The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D., F.A.C.S.

September 1941

Gynecology . Obstetrics

Proctology . Gastrointestinal Surgery

Orthopedics . New Instruments

Special Monograph

Compression of Cancellous Bone By EUGENE J. BOZSAN

INDEX TO VOLUME LIII IN THIS ISSUE

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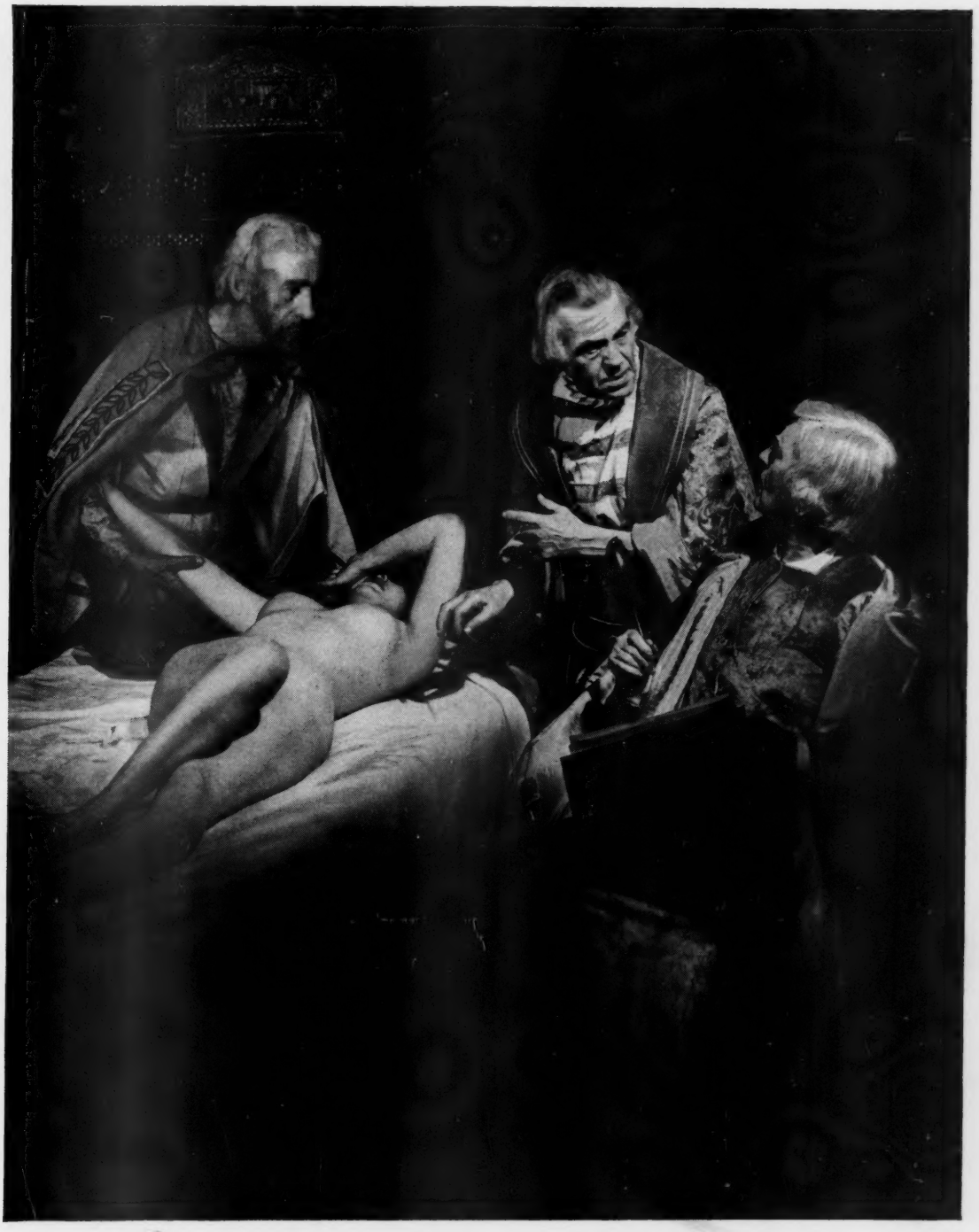

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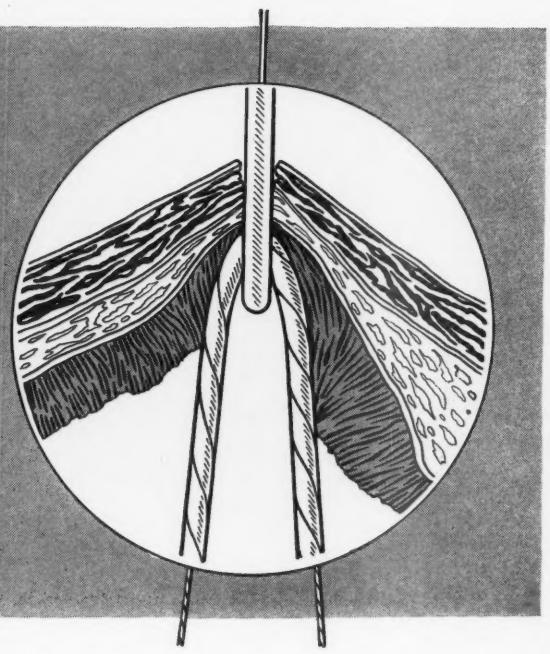

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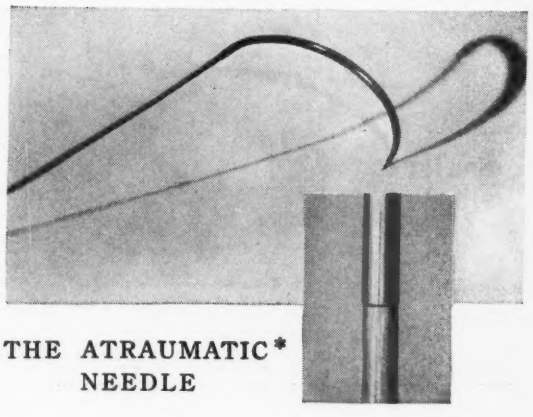

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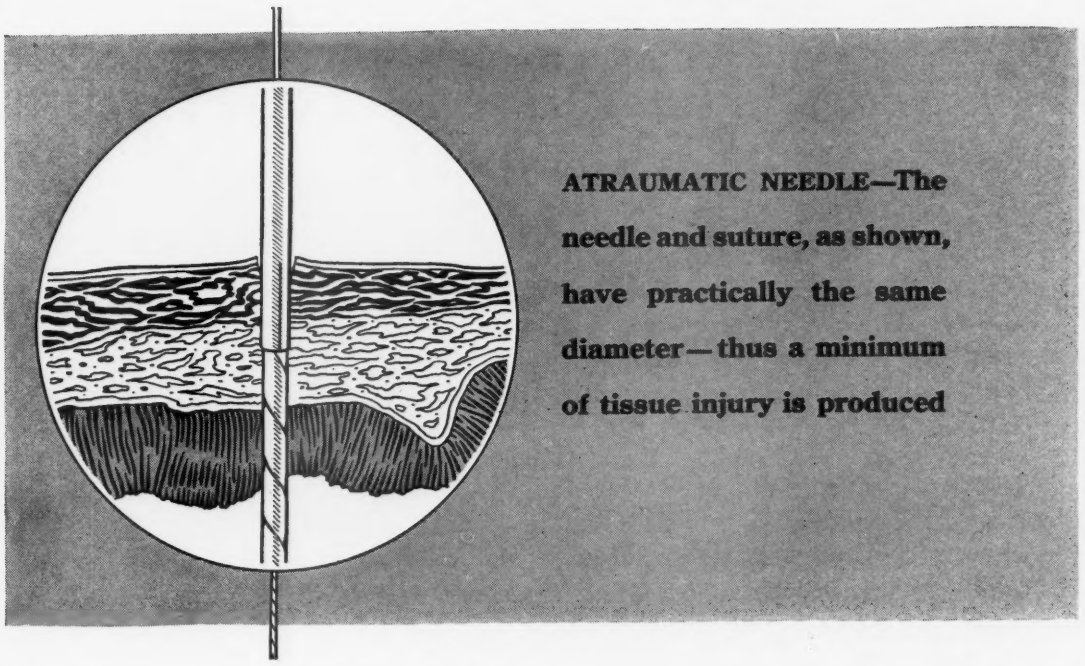

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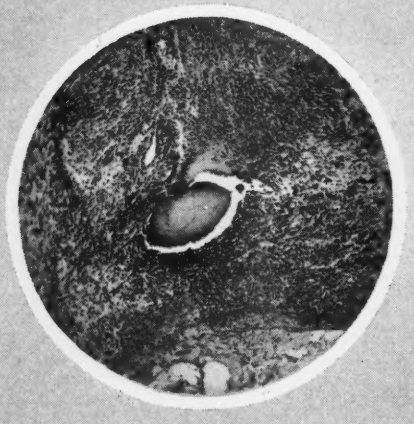
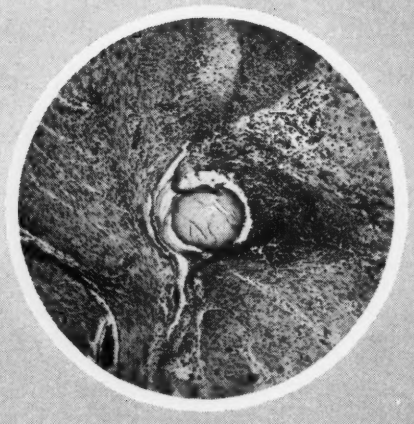


At 120 hours, histological section of size 5-0 medium chromic catgut demonstrates little cellular activity in tissue adjacent to suture.

Sustained integrity of suture



At end of healing period, histological section reveals that suture is still intact and that there is but slight round cell infiltration.

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NEW SERIES VOL. LIII — *Contents • September, 1941* — NUMBER THREE

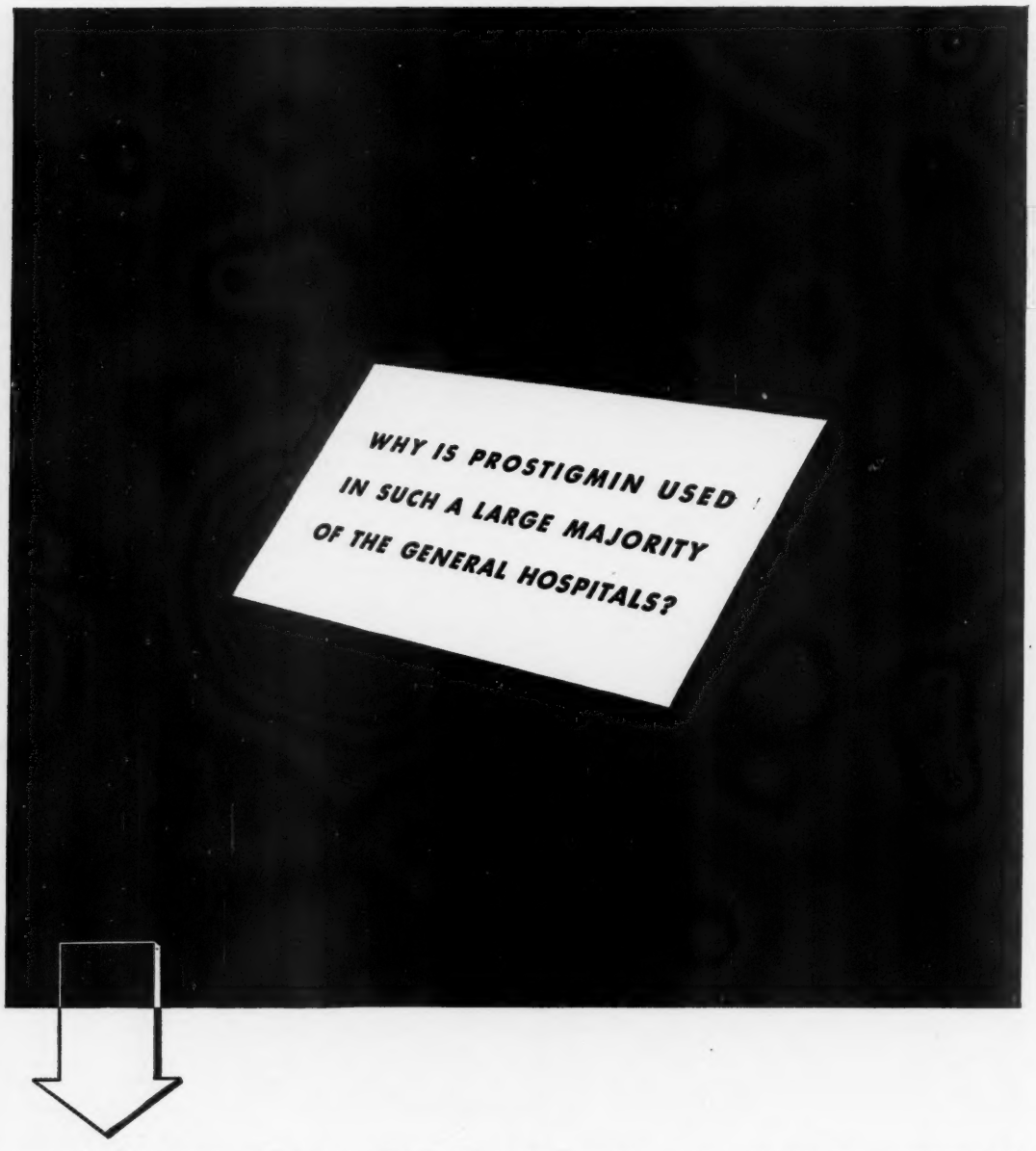
Editorial

A Way of Life, and "I Am an American" . . . . . *T. S. W.* 391

Original Articles

Perforations of the Intestine by Ingested Foreign Bodies. Report of Two Cases and Review of the Literature . . . . . *Joseph E. Macmanus* 393
Fractional Spinal Anesthesia . . . . *Morris J. Nicholson, Urban H. Eversole and Leo V. Hand* 403
Malignancy of the Vulva . . . . . *L. Wallace Frank and A. J. Miller* 412
Surgery in Patients over Fifty with Obstructing Pyloric Lesions . . . . *Gaston A. Carlucci* 417
Treatment of Large Hydroceles by Injection of Sodium Morrhuate . . *Jarratt Padgett Robertson* 421
Submucous Method in the Treatment of Anorectal Diseases . . . . . *Arthur S. Calman* 428

Contents Continued on Page 3



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Use of a Sulfhydryl Solution in the Treatment of Burns. Preliminary Report . . *Wilmot F. Pierce* 434
Embolic Vascular Accidents of the Extremities . . . . . *Ben H. Brunkow* 440
Osteopetrosis. Four Cases in One Family . . *Norman L. Higinbotham and Stewart F. Alexander* 444
End Results of Synovectomy of the Knee Joint . . *Ralph K. Ghormley and David M. Cameron* 455
New Method of Closed Reduction of Fracture of the Lateral Condyle of the Tibia . . . . . *Martin Dobelle* 460
Colostomy and Ileostomy: A New Method . . . . . *M. E. Steinberg* 463
Iron as a Therapeutic Supplement in Peptic Ulcer Therapy . *Irving Ehrenfeld and Robert P. Wallace* 470
Secondary Operations on the Biliary Tract. . . . . *Howard M. Clute* 475
Amniotic Fluid (Amfetin) in Its Relation to Inflammation. Observations in the Rabbit and in Man . . . . . *R. H. Rigdon and J. W. Warren* 481
Symptoms and Signs of Metastatic Cancer. . . . . *Richard B. Phillips* 486
Closure of Difficult Abdominal Incisions . . . . . *Arthur J. Dalton* 490

Case Reports

Penetrating Wound of the Heart with Electrocardiographic Tracings *R. L. Mustard, J. Solovay and Harold Ford* 492
Osteochondritis Dessicans of the Left Elbow . . . . . *Edward J. Kilfoy* 496
Torsion of Ovarian Cysts in Children. Report of a Case with Recovery . . *Durand Benjamin* 500
Puerperal Septicemia Following Spontaneous Delivery. Report of a Fatal Case *A. Charles Posner* 503
Liver Abscess Caused by Bacteroides Funduliformis . . . . . *C. F. Goodnough* 506
Brenner Tumor of the Ovary. . . . . *David M. Grayzel and H. Harold Friedman* 509
Massive Intestinal Hemorrhage in Regional Enteritis. Report of a Case . *Lawrence Sidney Fallis* 512
Use of a Vitallium Testicular Implant . . . . *Joseph Girsdansky and Herbert F. Newman* 514

New Instruments

Modified Kielland Forceps and Principles of Application. . . . . *Louis Drosin* 515
New Sponge Forceps and Blunt Dissector . . . . . *Harry Kirschbaum* 519

Bookshelf Browsing

Medicolegal Problems and Advances Made in Connection Therewith. . *Richard A. Leonardo* 521
Conquerors of Yellow Fever. . . . . *Illustration* 530
Selected Book Review. 532

Special Monograph

Compression of Cancellous Bone. . . . . *Eugene J. Bozsan* 537

Author Index to Volume LIII. 619
Subject Index to Volume LIII. 620

General Information on Page 4 *Advertisers Index on 3rd Cover*

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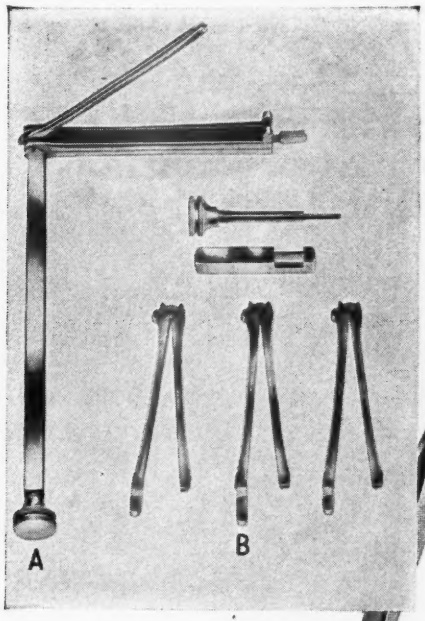

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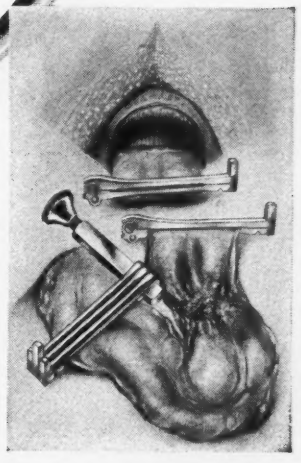

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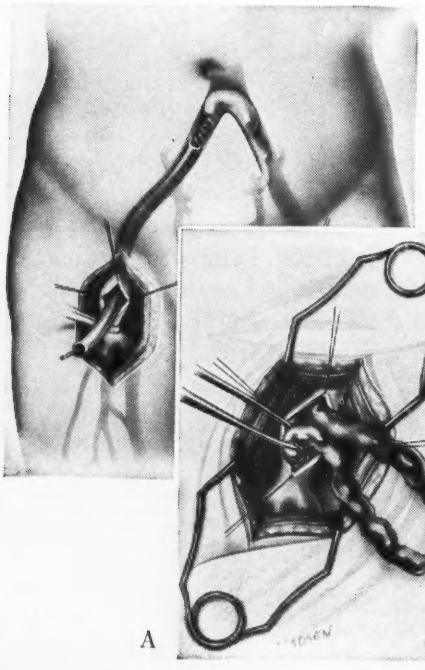

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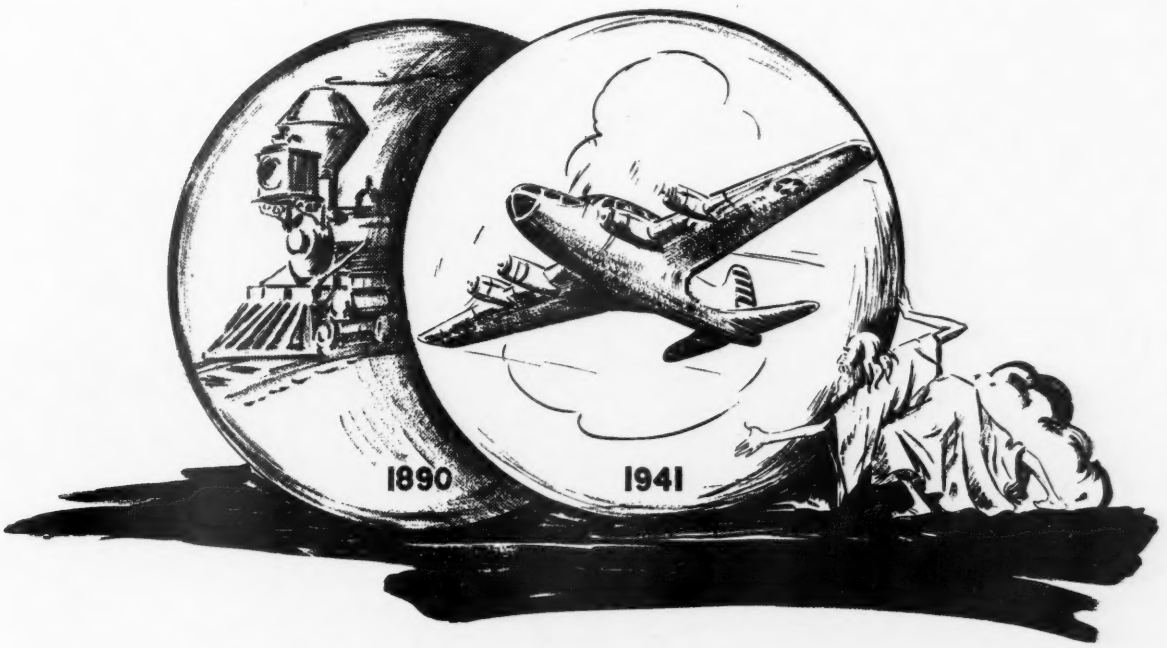

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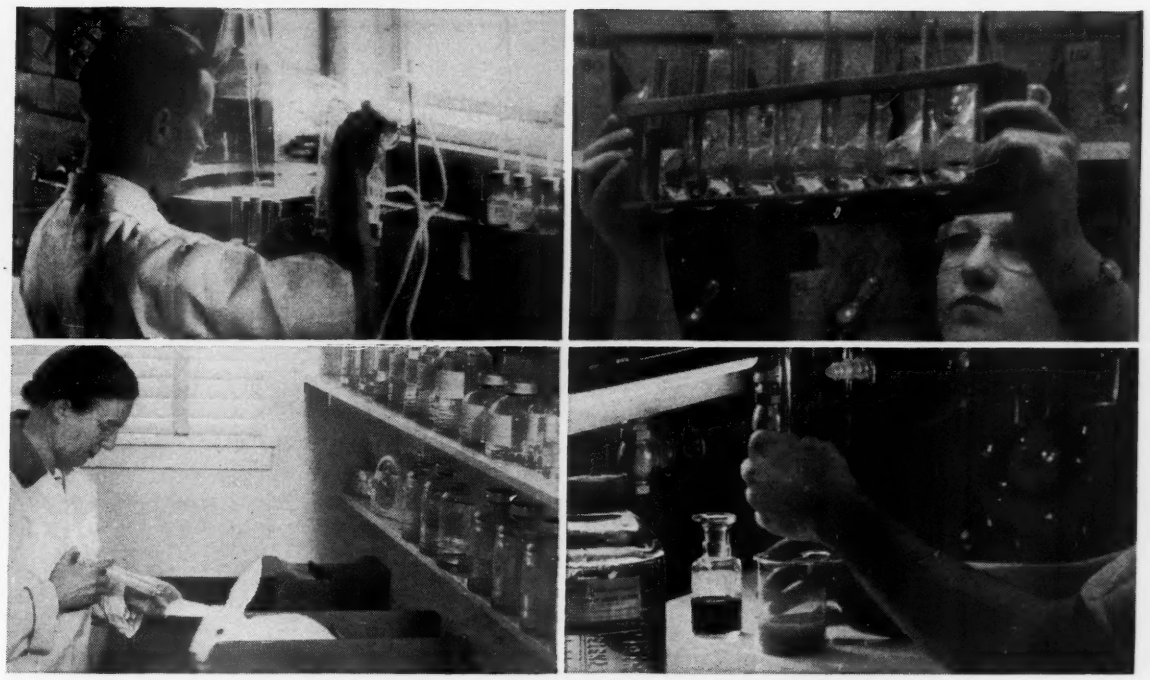

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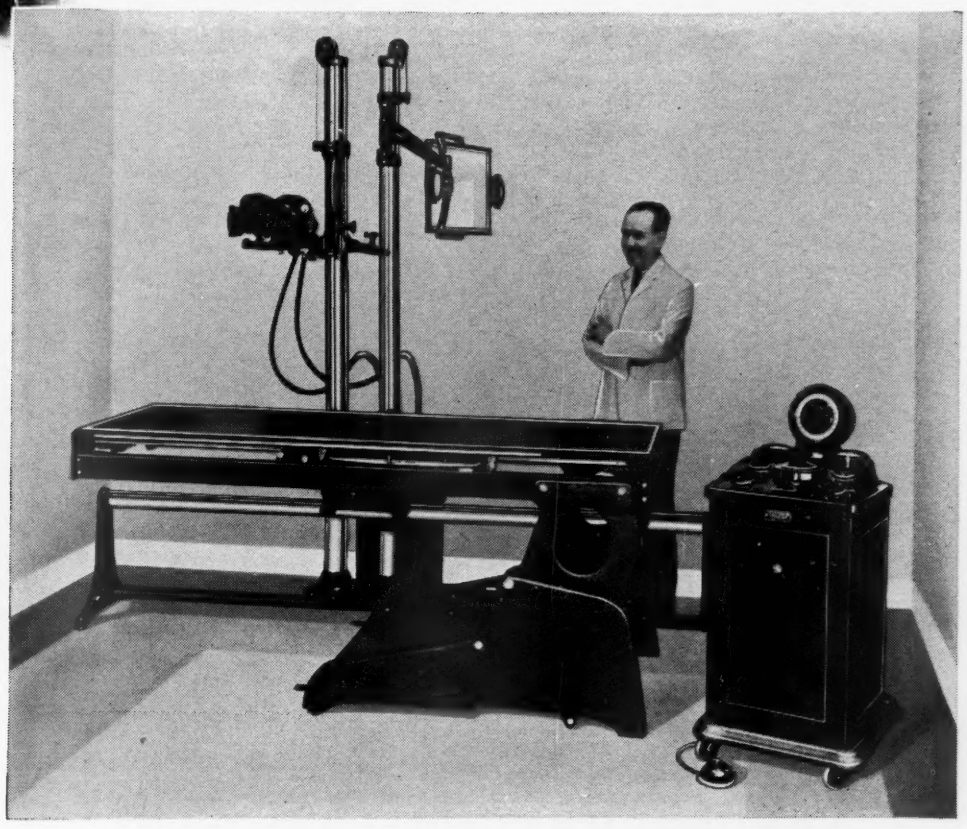

"He wanted power—chests at six feet in a tenth of a second. He wanted diagnostic quality—the kind you get if you have our DX Tube and our R-2 generator and control. He wanted performance—beauty—durability—long-time economy. In short, he wanted G-E.

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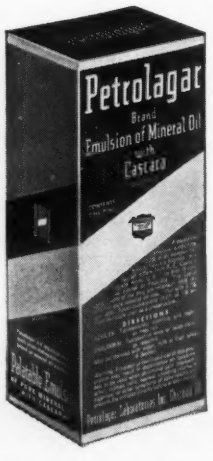

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The dose of Petrolagar with Cascara is one tablespoonful two to three times daily—gradually diminished. It has the advantage of exceptional palatability and continued effectiveness despite prolonged use.

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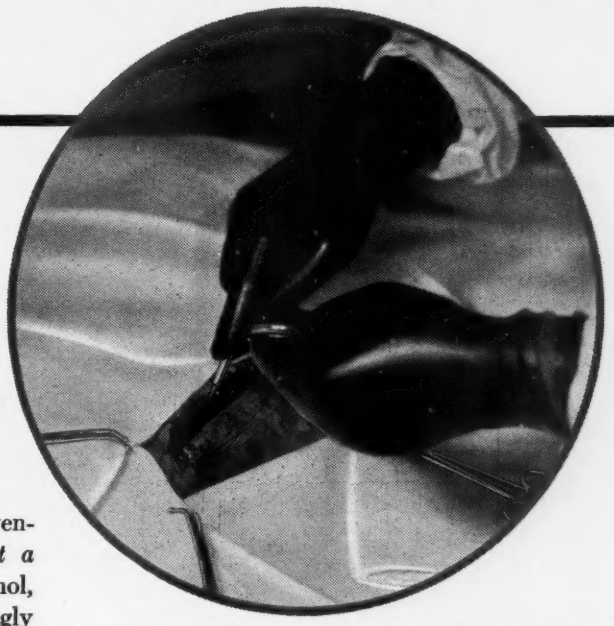

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An active detergent. A ZEPHIRAN scrubbing emulsifies skin fats, loosens and rolls off dirt and dead skin cells so that it exposes the underlying skin and bacteria more completely to its germicidal action.

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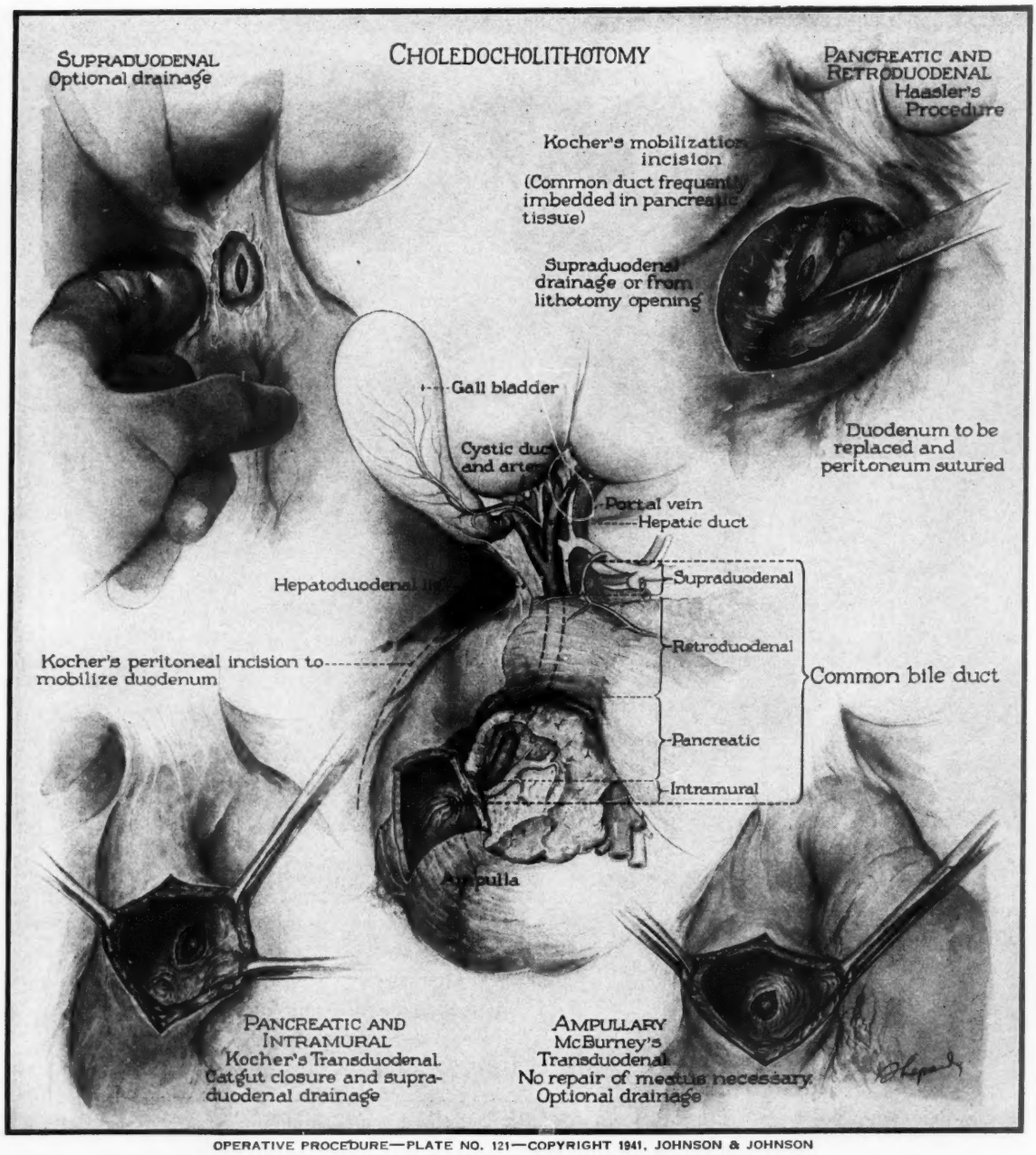

OPERATIVE PROCEDURE—PLATE NO. 121—COPYRIGHT 1941, JOHNSON & JOHNSON

Operations on Biliary Tract (No. 3)

The meticulous care in handling tissues during operative procedure is no more important than care in choosing the proper catgut for suturing. Tissues are vital. Catgut, too, is vital, in the confidence and trust placed in it by the surgeon. The science of surgery and the art of suturing are embellished by the use of proper catgut. Catgut making is a science and its use is an art. Ethicon Sutures are worthy of the surgeon's skill.

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A PRACTICAL JOURNAL BUILT ON MERIT

NEW SERIES VOL. LIII SEPTEMBER, 1941 NUMBER THREE

Editorial

A WAY OF LIFE, AND "I AM AN AMERICAN"

INSTEAD of writing on some phase of a surgical problem or discussing the newer economic threats to the profession we quote from two articles reported in the *New York Herald Tribune* (July 9, 1941). We predict that both John D. Rockefeller's "principles . . . which I learned at my mother's knee," and the letter of an unidentified resident of Missouri received by President Roosevelt will be given wider circulation in many publications.

John D. Rockefeller, Jr., in a radio broadcast opening the drive for the United Service Organization, listed among other things, "the principles in which my father believed and by which he governed his life. . . . They point the way of usefulness and happiness in life, to courage and peace in death. . . . Let me state them:

"I believe in the supreme worth of the individual and in his right to life, liberty and the pursuit of happiness.

"I believe that every right implies a responsibility; every opportunity, an obligation; every possession, a duty.

"I believe that the law was made for man and not man for the law; that government is the servant of the people and not their master.

"I believe in the dignity of labor, whether with head or hand; that the world owes no man a living but that it owes every man an opportunity to make a living.

"I believe that thrift is essential to well ordered living and that economy is a prime requisite of a sound financial structure, whether in government, business or personal affairs.

"I believe that truth and justice are fundamental to an enduring social order.

"I believe in the sacredness of a promise, that a man's word should be as good as his bond, that character—not wealth or power or position—is of supreme worth.

"I believe that the rendering of useful service is the common duty of mankind and that only in the purifying fire of sacrifice is the dross of selfishness consumed and the greatness of the human soul set free.

"I believe in an all-wise and all-loving God, named by whatever name, and that the individual's highest fulfillment, greatest happiness and widest usefulness are to be found in living in harmony with His will.

"I believe that love is the greatest thing in the world; that it alone can overcome hate; that right can and will triumph over might."

"These are the principles, however formulated," he said, "for which all good men and women throughout the world, irrespective of race or creed, education, social position or occupation, are standing, and for which many of them are suffering and dying.

"These are the principles upon which alone a new world recognizing the brotherhood of man and the fatherhood of God can be established."

The writer of the following letter to President Roosevelt is an American citizen of Czechoslovakian ancestry. He outlines the reasons why he was pleased with his citizenship, as follows:

"Dear President Roosevelt:

"I am a married man twenty-eight years old; a boy, three, and a girl, one. Here's how I feel about being an American.

"My ancestors were Czecho-Slovakians, my wife's English; but we're Americans.

"I look at my refrigerator, my oil heater and my radio. I'm glad I'm an American.

"My children get cod-liver oil, nourishing food and a doctor's watchful care. They'll be glad they're Americans.

"This morning I went to church. Amongst my neighbors, unafraid and unmolested, I thanked God for giving us America.

"I went home to my wife and kiddies. My little boy, Douglas, came running and said, 'Hi, pop. You gonna take me to see the ribber?' and I said, 'Sure Doug, I'll take you to see the river.' 'And we'll stand on the bridge and see the car cars, pop?' 'Sure, Doug.' 'Pop, see the sun. Look, see, pop. It shine in the car car's window.' 'Yes, Doug, the sun's shining on all America.'

"After our walk we came home and sat down to veal chops, baked potatoes, fresh green beans and corn on the cob. I said grace with tears in my eyes. I'm so happy I'm an American.

"This afternoon we listened to a radio rebroadcast of British children, here in America, talking to their parents in England, and I was proud to be an American.

"Tomorrow I'll go to work. I work in an electrotype foundry, and I love my job. I made it, in fact, from errand boy to production manager in two years. I had ideas and I told the boss about them. He's an American.

"Tonight, before going to bed, I told my wife, 'Honey, I'm going to buy a large flag and hang it out the window Friday. The President wants every one to pledge allegiance to a new and united America. And, honey, I'm going to do my part, because I'd rather be an American than anything else on earth.'"

After reading Mr. Rockefeller's "principles" and the above letter, we somehow felt better away down inside, and for this reason we rebroadcast them to you.

T. S. W.

Original Articles

PERFORATIONS OF THE INTESTINE BY INGESTED FOREIGN BODIES*

REPORT OF TWO CASES AND REVIEW OF THE LITERATURE

JOSEPH E. MACMANUS, M.D.
Resident Surgeon, Mary Imogene Bassett Hospital
COOPERSTOWN, NEW YORK

INTRODUCTION

THE ingestion of sharp indigestible foreign bodies is not a rare occurrence and in the great majority of instances the object proceeds uneventfully through the intestinal tract. Carp[1] has reported the gastroenteric history of forty-eight cases of ingested foreign bodies, ranging from pins and nails to needles, fishbones and sharp screws. He found that 83 per cent passed harmlessly through the intestinal canal. In a certain percentage (17 per cent) of the cases, however, the foreign body becomes lodged in some portion of the intestinal tract, and sooner or later a perforation may occur.

The present paper analyzes ninety-three cases of intestinal perforation by ingested sharp foreign bodies, collected from the literature, and adds a report of two recent cases. In one of these latter, the foreign body perforated a loop of gut while it lay incarcerated in a hernial sac—a rare occurrence which has been reported in only five of the ninety-three cases found in the literature. In the second case, the perforation was of a more common variety but illustrates many typical features.

CASE REPORTS

CASE I. No. 20499. A sixty-seven year old, married American housewife entered the hospital complaining of cramp-like pain in her abdomen and a "lump" in her left groin of one week's duration.

Present Illness. The patient had been entirely well until five months before admission when she noticed a soft, reducible, nontender mass in her left groin. Two weeks before admission it reappeared and since that time had been tender and hard. Seven days before admission she began to suffer midline, lower, abdominal cramps with some obstipation. This was followed by incessant vomiting. She had passed no stool and very little gas during the last two days before her admission. There were no urinary symptoms.

Physical Examination. The patient was a thin, elderly, moderately dehydrated woman, in some pain. Pulse 88, temperature 99.4°F. respirations 20. Her chest was symmetrical and the heart and lungs were normal. Her blood pressure was 150/80. There was moderate soft distention of the abdomen with active peristalsis. In the left inguinal region there was a firm, tender, lemon-shaped mass, 5 by 3 cm. in size. It seemed slightly elastic, was not movable or reducible, did not transilluminate and was dull to percussion. The subcutaneous tissues overlying this mass seemed slightly discolored and cyanotic. There was no impulse or fullness at the femoral ring on either side. Pelvic and rectal examinations revealed no further pathology. The peripheral reflexes were equal and physiological though slightly diminished.

Laboratory Data. Blood: hemoglobin, 87 per cent; red blood cells, 5.08; white blood cells, 8,050, polymorphonuclears, 67 per cent. Urine: Color, cloudy amber, specific gravity, 1.022; reaction, acid, sugar and acetone, negative,

* From the Department of Surgery, Mary Imogene Bassett Hospital, Cooperstown, New York.

albumin, slightest possible trace. Microscopic examination, negative. Stool: The guaiac test was positive.

Diagnosis. Left indirect inguinal hernia; strangulation of intestine due to hernia.

The patient was given preoperative fluids parenterally. A gastric lavage and preparations for a transfusion were carried out while the operating room was prepared.

Operation. The inguinal region was explored under local anesthesia. The mass was found to consist of indurated fascial layers covering an indirect congenital sac in which a loop of small intestine was strangulated. The section of gut lying in the sac was dark and cyanotic with greatly indurated walls. It presented a small perforation on its convexity through which a section of wire 3 cm. long protruded. (Figs. 1 and 2.) Specimens taken from the fluid lying within the sac were negative on smear but later culture yielded a colon aerogenes organism. The intestinal lumen was so obstructed by the inflammatory reaction and the viability of this section of gut so questionable that a resection was thought advisable. An end-to-end anastomosis was carried out and the wound closed in layers without drainage.

Postoperative Course. Except for an elevation of temperature during the first few days the postoperative course was uneventful. Despite the positive culture obtained from the fluid in the hernial sac the wound healed without gross infection. She left the hospital on the nineteenth day and has continued in good health.

Case II. No. 18528. A sixty-five year old, white American farmer entered the hospital with a chief complaint of generalized abdominal pain of forty-eight hours' duration.

Present Illness. About forty-eight hours before admission he was seized with a sudden sharp pain in the right lower quadrant of his abdomen which was sufficient to double him up and force him to grunt with pain. This pain persisted unabated for five hours and then gradually eased up a little. There was no nausea or vomiting. The pain radiated to the back and penis but was not accompanied by urinary symptoms. The discomfort continued throughout the next day. He had one bowel movement and ate two meals without distress. After a second sleepless night he entered the hospital for diagnosis and treatment.

Physical Examination. This farmer was a pale, thin, middle aged man lying quietly in bed with his knees flexed. Pulse 100, temperature 101.2°F., respirations 28. The chest was symmetrical, the heart was of normal size and position without any murmurs; the blood pressure was recorded as 130/70. Abdominal examination revealed some tenderness throughout all quadrants with rebound tenderness referred to the right lower quadrant and spasm over the entire right half of the abdomen with an area of exquisite tenderness just medial to McBurney's point. Rectal examination revealed tenderness on both sides of the pelvis. The extremities were normal and reflexes physiological.

Laboratory Data. Blood: hemoglobin, 90 per cent; red blood cells, 4.77; white blood cells, 11,250; polymorphonuclears, 71 per cent. Urine: color, cloudy yellow, specific gravity 1.017; reaction, acid, albumin and sugar, negative, microscopic examination showed rare white and red blood cells.

Diagnosis. Acute appendicitis.

Operation. The abdomen was opened through a low right rectus incision. The cecum appeared to be the most indurated organ, the appendix appearing much less injected and only secondarily involved. After removing the appendix more careful exploration revealed a small, well walled-off perforation of the lateral wall of the cecum through which a toothpick was protruding. (Fig. 3.) The foreign body was removed, the perforation sutured, a drain inserted and the abdomen closed. A culture taken from the lateral wall of the cecum was oddly enough sterile under both aerobic and anaerobic conditions.

Postoperative Course. He ran a relatively mild course throughout his convalescence. The drains were removed on the eighth day and the wound closed spontaneously before his discharge on the twentieth day after operation. Since leaving the hospital he has been seen on one occasion. At that time he presented no hernia or weakness in his wound and was complaining of no gastrointestinal symptoms. In retrospect he declared he could not recall having swallowed the toothpick.

REVIEW OF THE LITERATURE

Ninety-three cases* have been collected from the literature as suitable for study.

*Cases of perforation by ingested blunt foreign bodies have not been included because it is usually impossible to be certain of the primary rôle of the foreign body in the evolution of the pathology. Viz: one

Of these, thirty-two were analyzed by Mitchell[2] who wrote an excellent paper on the subject in 1899. Since that time sixty-one cases have been collected by other authors[3–54] which with the two reported in this paper make up the total of ninety-five. While an attempt has been made to collect all the cases reported, it is doubtless true that some may have been overlooked. Many cases occur which are not reported. Others are presented in such a fragmentary manner that one is not able to include them in an analytical study. It will be noted that a different number of cases is used for analysis under the several headings presented; this is due to the fact that the histories have not in every case afforded complete information.

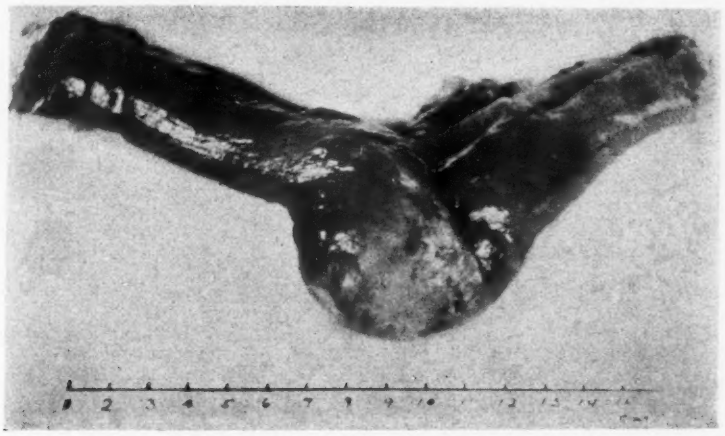

Fig. 1. Case 1. Photograph of the portion of small intestine resected at operation. The rounded mass in the center is the indurated, inflamed loop of intestine that had been incarcerated in the hernial sac. The perforating object (a small wire, not shown in the photograph) was found protruding from the center of the incarcerated mass.

Age. Although it is true that approximately 50 per cent of the cases appear in the first three decades of life, only 18 per cent of the cases were found in the first decade. The third and fifth decades were responsible for 17 per cent each of the total number of patients. The second, fourth, sixth, seventh and eighth decades had a decreasing percentage of the total, respectively (Fig. 5.) In only one case did the patient have any knowledge of the ingestion of the foreign body.

Sex. The sex was mentioned in eighty-seven cases. Fifty-one were males and thirty-six females. Except for the third decade of life the relative proportion of males and females runs evenly throughout the decades. (Fig. 5.) The great disproportion between the sexes in the third decade is not easily explained.

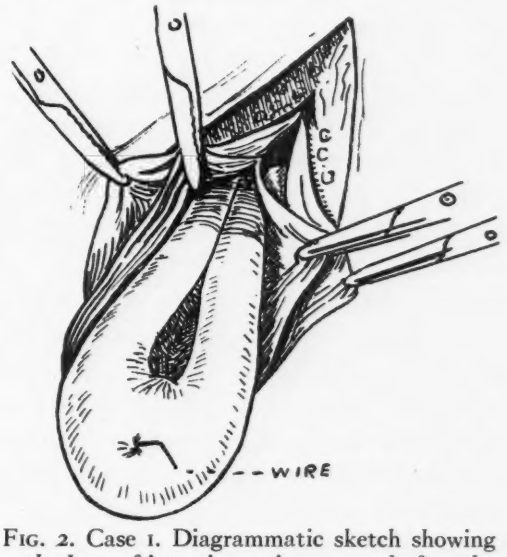

Fig. 2. Case 1. Diagrammatic sketch showing the loop of intestine as it appeared after the hernial sac had been opened. The small crooked segment of wire can be seen protruding from the distended portion of the loop. (See Figure 1.)

occasionally sees grape seeds and fecoliths, etc., which are associated with perforating lesions of the appendix, but one usually feels that the inflammatory process was primary and the perforation secondary even though the object may have initiated the process by obstruction.

Types of Foreign Bodies. The objects found in this study can be classified into three broad groups. The first group is composed of metallic bodies, under which may be included pins of various descriptions and segments of wires. Animal bones, comprising fishbones and chicken bones, and also a wide variety of fragments of bony spicules ranging from portions of a rabbit's rib[3] to teeth[4] make up the second group. Wood splinters, including toothpicks and in one case the portion of a pencil were responsible for the remainder of the perforations.

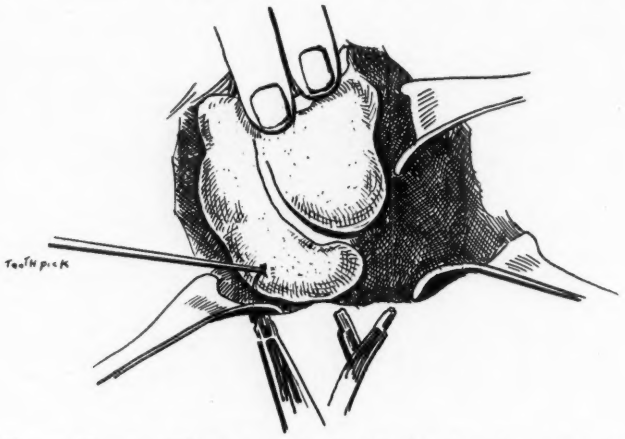

FIG. 3. Case 11. Diagrammatic sketch showing the approximate point of perforation of the wall of the cecum by the toothpick.

Among the entire group of foreign bodies the metallic objects numbered 45 or 46 per cent of the total. J. F. Mitchell's[2] excellent review of a series of perforations due to the common pin has materially increased the percentage of this type of foreign body. The pins varied from ordinary household varieties to hairpins and needles.[7] Six cases of perforation due to segments of wire were discovered in this series. One of these is represented in the case reports at the beginning of this article.

Segments of various types of bones were found in thirty-nine cases. In twenty-six members of this small group the perforations were due to fishbones, which seems natural since fish is a common food. Chicken bones were responsible for only four cases. In the remainder of the cases in this group an interesting collection of bony objects were found. Poulet[8] reports the foot of a lark, Hawkyard and Armitage[3] report a rabbit's rib, Ackerman[9] a pork bone, Carp[1] a bird bone, Garberson[10] a porcupine quill, Matyas[11] a goose bone and duck bone, Porzelt[5] a hen's rib, and Meyer and Rossi[4] reported three cases due to the perforation of the intestine by teeth.

Toothpicks and wood splinters of various sorts caused perforations in nine cases or 9 per cent of the whole group.*

Sites of Perforation. The site of perforation was stated exactly in eighty-eight cases (Fig. 4.) The cardio-esophageal junction, the pylorus and the natural angles in the first and second portions of the duodenum provide both relatively fixed points and considerably narrowed passageways. Though one might expect the greatest number of perforations just proximal to these fixed points, very few perforations were reported at these sites. The gastric, duodenal and jejunal regions accounted for but five cases. The great preponderance of perforations of the lower ileal and cecal regions is striking. Excluding the large group which occurred in the appendix and in Meckel's diverticulum, there were twenty perforations in these regions.

Appendiceal perforations were found in thirty-four cases. A number of interesting facts are revealed in this small group. The first recorded case of an appendicectomy on a living subject arose in connection with a

* Case 11 belongs to this group.

perforation of the appendix by a foreign body.*

In addition to the case described briefly in the footnote and that reported by the author in the present study there have been four other cases of perforation of the intestinal tract by foreign bodies while the gut was caught in an hernial sac. Four of these cases were perforations of the appendix and two were perforations of the ileum.

Meckel's diverticulum was a frequent site of arrest and subsequent perforation of the sharp foreign body. R. C. Webb[13] collected six cases. Four others are reported by Donovan[6] Lindqvist[14] and Blanc.[15]

The colon was perforated fifteen times. The hepatic flexure accounted for three, the transverse colon one, the splenic flexure two, the descending colon one, the sigmoid five, and in three cases the site of perforation was not stated. The rectum was the site of penetration in three more cases.

In the seven cases in which the exact site of perforation was not known, the foreign bodies were found lying within abscesses in various recesses of the peritoneal cavity. In each of these cases, no visible perforation was detectable on careful inspection of the walls of these abscesses.

Duration of Symptoms. This phase of the subject was difficult of accurate appraisal. The duration of symptoms was stated definitely in seventy-four of the histories. Fifty patients in this series had had symptoms ranging from three hours to two weeks. In the remaining twenty-four cases the histories ranged from two weeks to twelve years in length. An attempt to relate the site of perforation to the duration of symptoms led to the conclusion that there was no relation between these two factors. The patients presenting the short histories were not found to have had their perforations in any particular region of the intestinal canal.

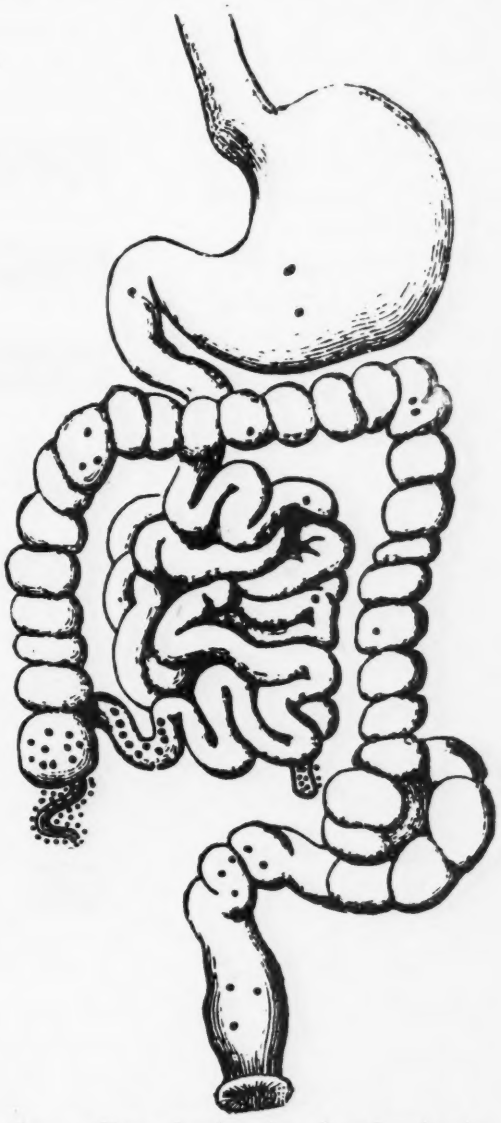

Fig. 4. Chart showing site of perforation in eighty-three cases studied. (In the remaining twelve cases the location was not specifically stated.) Each dot represents a perforation, the numbers being as follow:

Stomach	2
Duodenum	1
Jejunum	2
Meckel's diverticulum	10
Ileum	10
Cecum	10
Appendix	33
Colon	
Hepatic flexure	3
Transverse colon	1
Splenic flexure	2
Descending colon	1
Sigmoid	5
Rectum	3

* Amyard Claudius, in 1735, is quoted by Deaver[12] as having seen a boy of five years of age for a discharging sinus of the right thigh of many years' duration, which had been accompanied by an irreducible scrotal hernia. In the course of a very difficult operation he came upon the appendix wrapped in omentum lying in a hernial sac. The appendix had been perforated by a pin the head of which lay in the appendix encrusted with fecal contents. The appendix was removed and the boy made a protracted recovery.

Types of Symptoms. There were two types of histories. The one was dramatic. Patients complained of a sudden, sharp midabdominal pain which remained constant and severe and was usually accompanied by vomiting. If untreated, the picture in this type of case rapidly developed into that of a general peritonitis. The element of shock which is so often found in the early stages of a perforated gastric or duodenal ulcer was not described. These cases were, no doubt, associated with a sudden perforation of the intestinal tract with immediate soiling and subsequent infection of the peritoneal cavity. The other history related a more gradual onset of abdominal pain with low grade fever, anorexia and localized tenderness. As the days passed the patients developed the clinical picture of a localizing intraperitoneal inflammatory mass. In general the type of symptoms have followed one of the above patterns though there were individual cases with rather bizarre lengthy stories. In the three rectal cases tenesmus, diarrhea and bloody stools were encountered with regularity. Perirectal infection with its attending pain, perineal edema, fever and anorexia were constant findings.

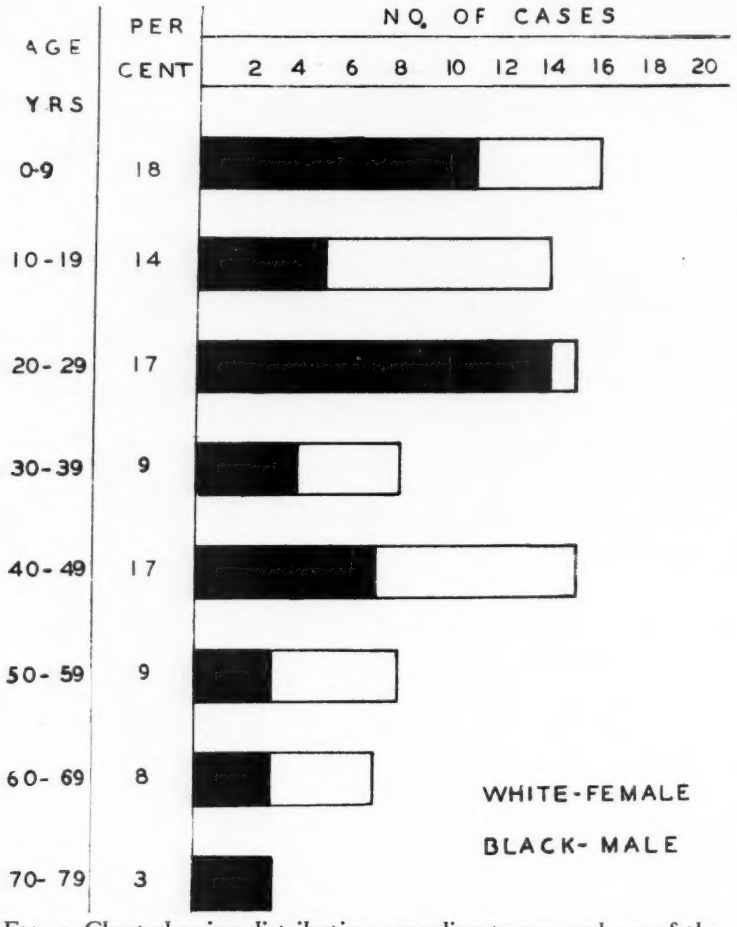

FIG. 5. Chart showing distribution according to age and sex of the ninety-five cases reviewed.

Pathology and Complications. In discussing the pathology subsequent to the perforation of the intestinal tract by sharp foreign bodies we find it quite easy to classify the cases into several groups depending upon the relation between the suddenness and quantity of the contamination of the peritoneal cavity and the ability and speed with which the defensive forces within that cavity can be mobilized. Ninety-three of the ninety-five cases in this review afforded a history sufficient to determine the type of pathology present.

The cases fall into five groups: (1) Early localized peritonitis; (2) indurated inflammatory tumors; (3) abscesses; (4) general peritonitis, and (5) hemorrhage.

Group 1. *Early Localized Peritonitis.* Seventeen cases fall into this group. Here usually the acute perforation was small, the foreign body was often metallic and found plugging the perforation. A local peritoneal reaction developed consisting of light fibrinous adhesions glueing the intestinal coils together about the site of perforation. In all but two of the instances the segment perforated was found to lie in the region limited by the ileum and cecum.

Group 2. *Indurated Inflammatory Tumors.* There were fourteen cases of this type. They were characterized by the presence of an inflammatory mass of indurated omentum and visceral peritoneum, which had effectively walled off the perforating agent and in which no actual purulent fluid had formed. Poulet[8] holds that this type of reaction represents the first phase in the life history of migratory foreign bodies. He suggests, that the object may tend to work its way anteriorly toward the abdominal wall causing moderate induration of opposing intestinal loops and parietal peritoneum. Eventually the foreign bodies may reach the abdominal wall where they are either surrounded by indurated fat and fascia or are actually found lying in a small abscess.

Group 3. *Abscesses.* There were forty-two cases in this series which developed abscesses subsequent to the perforation. One was situated in a hernial sac and three in the perirectal tissues. Four cases in this group appear to be examples of a migratory type of pathology. Durman and Beltz[17] reported a case of an abscess of the abdominal wall in a forty-eight year old woman in which a toothpick was found lying free in the abscess cavity. Mitchell's review[2] contains the histories of three individuals in whom a chicken bone and fishbones were found in abscesses of the abdominal wall. Five of the remaining thirty-four cases in this group afforded no evidence at operation or at autopsy of the actual site of perforation. Eighteen cases were described as right lower quadrant abscesses secondary to perforations of the cecum, appendix and ileum. In addition to developing intraperitoneal abscesses about the site of perforation six cases were associated with hepatic abscesses. This represents an incidence of 6.4 per cent of hepatic abscess in the entire series. As one might suspect, these cases presented long histories extending from one to sixteen weeks during which the primary focus had remained as an undrained abscess. The extension of the infection to the hepatic parenchyma was usually detected at autopsy. These six cases are contained in Mitchell's[2] report, which was written in 1899. During the latter decades of the nineteenth century a conservative attitude toward abdominal exploration was prevalent, even though the development of the modern era of surgery had already begun in larger clinics. A review of these early cases allows us to observe the dire consequences of permitting localized, suppurative intraperitoneal lesions to remain undrained for long periods of time.

Three cases in this group (abscesses) or 3 per cent of the entire series developed fecal fistulae. The low incidence of postoperative fistula is surprising when one realizes that no opportunity was afforded the operator to suture accurately the perforation in this group. There were no cases of fistula found in any of the other groups. Of the three fistulae encountered one closed spontaneously in three or four weeks, another required surgical closure and the third was found in a patient who succumbed to the effects of sepsis and toxemia.

Group 4. *General Peritonitis.* Eighteen cases of general peritonitis were found. Two of them were due to perforations of the sigmoid and one of them to perforation of the jejunum. The remainder of the cases were distributed throughout the lower ileal and cecal regions. Nine cases in this group were caused by metallic foreign bodies; in the remainder, bony and wooden objects were responsible for the catastrophe. No

relation between age and the development of peritonitis was detected. This calamity occurred both in youth (age 7½)[12] and in old age (age 66)[18].

Group 5. Hemorrhage. Only one case of this type was discovered. Wolfen and Lieblien[19] reported a case in which a fish-bone perforated the gastric wall and in so doing pierced a large branch of the right gastric artery causing rapid death.

Mortality. Omitting two cases in which the final outcome was not stated, we have ninety-three cases from which to estimate the gross mortality of the series. There were twenty-four deaths or a total mortality of 25.9 per cent.

If one divides the cases which terminated fatally into those occurring before and those after 1900, an interesting comparison develops. This date is an arbitrary one but affords some dividing line between the surgical periods represented in this review.

The period before 1900 contains thirty-three cases. Mitchell's series[2] contains thirty-five cases of which thirty-two are included in this report. Seventeen of these patients died. Mitchell published his paper in 1899. This fatal group together with one reported to have occurred in 1691[20] constitute eighteen deaths in this period or a mortality of 53.5 per cent. Practically every fatality in Mitchell's series had occurred without surgical intervention. Those patients in his series who survived did so usually because abscesses either drained spontaneously or did not require entrance into the general peritoneal cavity for their approach.

In the period 1900 to 1940, there were sixty cases. Six of these patients died, producing a mortality of 10 per cent. Four of this group had succumbed to general peritonitis. It is in this pathological group that little can be accomplished in an operative manner once the general infection has developed. There is little doubt that early operation in an acute abdominal emergency, the satisfactory drainage of the localized intraperitoneal abscess at the optimum time and the more careful attention toward preventing and combating abdominal distention, dehydration, loss of protein, electrolytic imbalance and vitamin deficiency in these desperately sick patients have been effective. The marked difference in the mortality of the two groups, 53.5 per cent in one and 10 per cent in the other, affords one a means of measuring our progress in the early recognition and effective treatment of acute peritoneal inflammation and infection.

The relation of mortality to the type of pathology is an interesting one. The group in which a local peritoneal inflammation or an indurated inflammatory mass was found had no deaths in either of the surgical periods. Those, however, with abscesses and generalized peritonitis showed a striking improvement in their mortality figures for the period after 1900. While before 1900, patients in the abscess group showed a 52.6 per cent mortality, since 1900 the mortality of patients in this group has dropped to 8.7 per cent. We must remember that in the former group (before 1900) there were a number of complicating pathological features which operated toward increasing the mortality. Multiple and disseminated abscesses were found in seven of these fatal cases. Cases which developed peritonitis before 1900 universally died, whereas those suffering from this disease from 1900 to 1940 showed a mortality of only 36 per cent.

SUMMARY

A report in detail of two cases of perforation of the intestinal tract by ingested, sharp, foreign bodies has been presented. In one instance the perforation occurred in a loop of intestine lying incarcerated in a hernial sac. The other case was a perforation of the cecum by a toothpick. Ninety-three cases have been collected from the literature and studied. The following points were brought out:

1. The types of foreign bodies ingested included metal objects such as pins and wires; bony objects such as chicken or fish

bones; wooden splinters; and other bizarre pointed bodies.

2. Seventy-three per cent of the perforations occurred in and around the ileocecal region, the remainder being distributed generally from the stomach to the rectum.

3. Six cases of perforation of the intestine with a hernial sac were reported.

4. Duration of symptoms ranged from a few hours to two weeks in 50 per cent of the cases. The remainder of the cases had longer histories.

5. Types of pathology observed were classified into five groups: early localized peritonitis, inflammatory masses, abscesses, general peritonitis and hemorrhage.

6. The mortality in respect to the surgical period before and after the year 1900 shows a 53.5 per cent mortality in the former period and 10 per cent in the latter.

Table 1

TABLE INDICATING RELATION OF TYPE OF PATHOLOGY TO MORTALITY IN THE PERIODS BEFORE AND AFTER THE YEAR 1900

Type of Pathology	Number of Cases	Deaths	Mortality, Per Cent
Before 1900, 32 cases			
Abscesses	19	10	58.8
General peritonitis	7	7	100
Inflammatory masses	3	0	0
Local peritonitis	3	0	0
After 1900, 59 cases			
Abscesses	23	2	8.7
General peritonitis	11	4	36
Inflammatory masses	11	0	0
Local peritonitis	14	..	0

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FRACTIONAL SPINAL ANESTHESIA*

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SPINAL anesthesia has undergone many improvements since its discovery in this country by Corning[1] in 1885. Gradually many of its undesirable features have been eliminated or altered so as to make its beneficial characteristics more applicable clinically. The clinical use of spinal anesthesia really began in 1889 when Bier,[2] of Germany, injected cocaine intraspinally in man. With its introduction, anesthetists were immediately confronted with the need for a means of preventing the untoward reactions produced by spinal anesthesia, that is, toxic manifestations of cocaine and depression of circulation. Epinephrine was isolated in 1901 by Takamine,[3] and in 1903 its vasoconstrictor properties were applied to local and spinal anesthesia by Braun,[4] of Germany. In 1905, the less toxic drug, procaine hydrochloride, was introduced by Einhorn.[5] This drug made spinal anesthesia safer to use. The need for a vasoconstrictor of longer action than epinephrine was answered when in 1921 Chen[6] introduced ephedrine sulfate, and by 1927 Ockerblad and Dillon[7] and Rudolf and Graham[8] were administering it preliminary to spinal anesthesia in order to prevent blood pressure fall. This drug was responsible for a renewal of clinical interest in spinal anesthesia as it gave prolonged vasoconstrictor action and prevented much of the blood pressure fall formerly associated with subarachnoid block.

Even with a relatively nontoxic agent—procaine and an adequate vasoconstrictor, ephedrine—there was still much to be desired clinically in spinal anesthesia. Satisfactory height and duration of anesthesia were difficult and sometimes impossible to obtain by a single injection of a previously determined dose of the spinal anesthetic agent. Consequently, many new spinal anesthetic agents and method of administering them were introduced in an attempt to increase the controllability and duration of anesthesia. Soon the anesthetist had spinocaine, procaine, metycaine, pontocaine and nupercaine to choose from, with numerous methods of administration at his command. All too often, however, the anesthesia failed to develop, wore off sooner than expected or the operation took more time than was anticipated.

William T. Lemmon,[9] of Philadelphia, has provided the most recent advance in subarachnoid block anesthesia with his introduction of fractional (continuous) spinal anesthesia. This method of producing prolonged spinal anesthesia employs a short acting agent, procaine hydrochloride, which is injected in fractional doses as needed during the operation. Continuous spinal anesthesia is made possible by placing the patient on a specially designed mattress and allowing a very flexible, German silver, lumbar puncture needle to remain *in situ* during the operation. (Fig. 1A.) The needle is connected to a syringe by means of a thirty inch piece of rubber tubing which is provided with Luer-Lok connections at either end, making the system air and water tight. (Fig. 2.)

The rubber covered mattress† employed is five inches thick, eighteen inches wide and six feet long. It has a cut out part seven inches in length which comes under the lumbar spine when the patient is supine. The mattress is divided in half so that the portion which supports the lower extremities may be detached for perineal operations. (Fig. 3.) If an abdominal operation follows the perineal procedure, the patient may be pulled back into position and the

† Manufactured by Geo. P. Pilling and Son Co., Philadelphia, Pennsylvania.

* From the Department of Anesthesia, The Lahey Clinic, Boston, Massachusetts.

lower half of the mattress replaced and made secure to the upper half with a strap and buckle. (Fig. 4.) Provision has also been made to break the lower part of the mattress to allow the feet to be lowered when Trendelenburg position is desired. (Fig. 5B.) The shoulder braces require longer supporting irons to allow for the five inch thickness of this special mattress and the same may be said for the wrist restraints.

German silver needles possessing great flexibility are used and it will be noted from the illustration that these needles have a small hole through the bevel. (Fig. 1b and c.) This latter modification was made by Lemmon[10] to insure a free flow of spinal fluid, and this has been of value clinically when it has been necessary to employ barbotage to get the proper height of anesthesia. The ability to withdraw spinal fluid informs the anesthetist that the needle is still in the subarachnoid space and makes it possible, if toxic symptoms appear early, to decrease rapidly the concentration of the anesthetic drug.

We have employed as anesthetic agents procaine, nupercaine, metycaine and pontocaine.* Because of its shorter action, procaine seemed particularly well suited to this method of administration and most of our experience has been with this drug. After trying 10, 7, 5, 4, 3 and 2.5 per cent solutions, we have found a 3⅓ per cent solution in normal saline most satisfactory. This solution produces anesthesia in three to five minutes, and as each 3 cc. contains 100 mg., the calculation of the total amount used is simplified. In addition, it makes possible the use of a 4 to 5 cc. volume for induction without making the initial dosage dangerously high. Lemmon[10] reports satisfactory results with procaine hydrochloride in over 500 cases of fractional spinal anesthesia, having in the early part of his series employed a 10 per cent and more recently a 5 per cent concentration of procaine in spinal fluid.

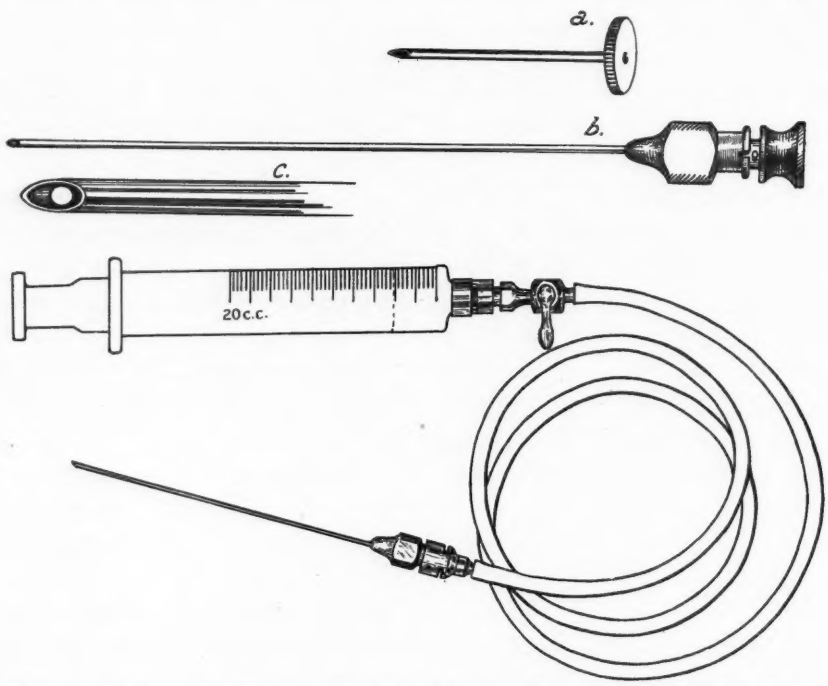


FIG. 1.

FIG. 2.

FIG. 1. a, Sise introducer; b and c, German silver needle showing hole through bevel to facilitate aspiration of spinal fluid.
FIG. 2. Syringe and needle connected to tubing by Luer-Lok connections.

* The Lahey Clinic (Sise) pontocaine-glucose technic for spinal anesthesia with modifications is being used satisfactorily for fractional spinal anesthesia (*Surg. Clin. N. Amer.*, 15: 1501–1511, 1935). A report of our findings will be published in the near future.

The spinal puncture is made, using either an 18, 19 or 20 gauge German silver needle, with the patient in the left lateral decubitus position so that the back is toward the side of the mattress with the opening in it. Routinely, 50 mg. of ephedrine sulfate is injected as part of the local anesthetic in the site selected for lumbar puncture. This selection depends on the operation contemplated. The lumbar interspaces used are: the second for upper abdominal procedures, the third for lower abdominal and the fourth for operations on the rectum or lower extremities. A Sise introducer (Fig. 1a) is used to puncture the skin and superficial interspinous ligaments and on withdrawal leaves a track for the soft, flexible German silver needle to traverse. Once the needle has been successfully introduced and spinal fluid flows freely, anesthesia may be induced.

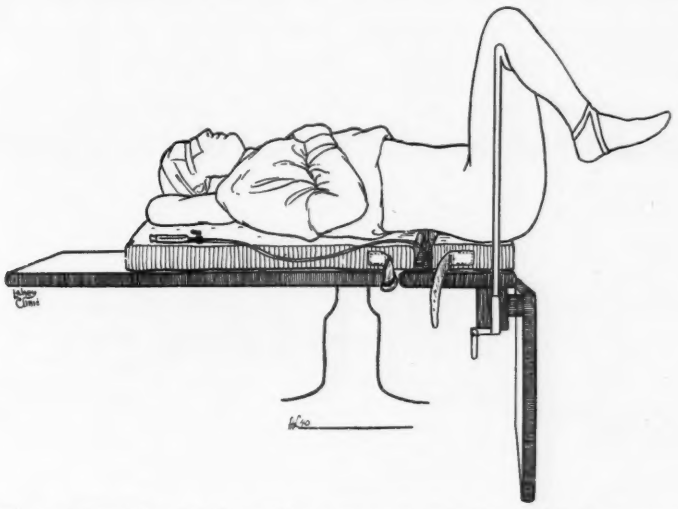


Fig. 3. Position of the patient on mattress for perineal operation, showing needle in place and lower part of mattress removed.

A 5 cc. ampule of 20 per cent procaine hydrochloride is diluted to 30 cc. with normal saline solution to make a 3⅓ per cent solution, each 3 cc. of which contains 100 mg. After the 20 cc. Luer-Lok syringe and tubing have been rinsed with sterile normal saline solution, the syringe is filled with the 3⅓ per cent solution and again connected to the stopcock which is attached to one end of a thirty inch piece of thick-walled, small bore rubber tubing.

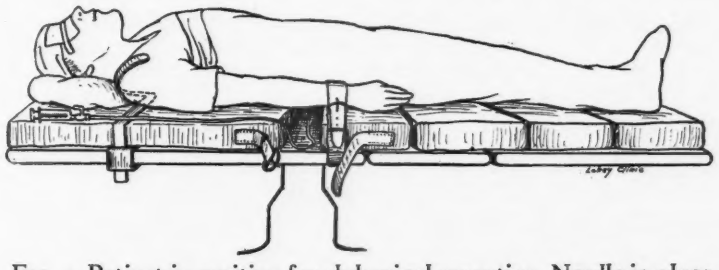


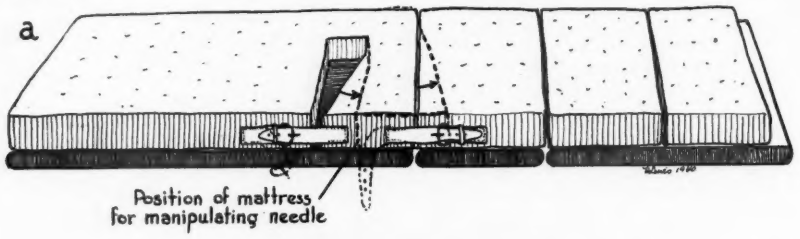
Fig. 4. Patient in position for abdominal operation. Needle in place and shoulder braces and wrist restraints adjusted.

The stopcock is opened and 2 cc. of the mixture is forced into the tubing, thus displacing the air and completely filling the tubing. Then the stopcock is closed. The Luer-Lok connection at the opposite end of the tubing is securely connected to the needle which is left in the spine. (Fig. 6.) If on opening the stopcock the plunger of the syringe is forced out by the cerebrospinal fluid pressure, or spinal fluid can be

aspirated into the tube with ease, the spinal puncture is satisfactory.

With the needle in place and the tubing connected, the patient is gently turned in the supine position and the needle is allowed to rest in the center of the gap in the pad, so that it does not touch the table or mattress at any time. (Fig. 3.) If complete abdominal anesthesia is desired, the patient is placed in a 5 degree Trendelenburg position for induction after the shoulder braces and wrist restraints have been properly adjusted. An initial injection of 2.5 cc. (85 mg.) to 3 cc. (100 mg.) of the mixture is made and the height of anesthesia tested after five minutes. If the desired level of anesthesia has not been obtained, an additional injection, generally of 1 cc., is made. Since the specific gravity of the anesthetic solution is greater than that of spinal fluid, the factor of gravity as well as volume, barbotage and site of injection may be brought into play to obtain the desired height of anesthesia.

To familiarize ourselves with fractional spinal anesthesia, a group of cases requiring time-consuming operations on the lower extremities was selected. Gradually, as confidence was acquired and the merits of this type of anesthesia were demonstrated to the satisfaction of both surgeon and anesthetist, we included more difficult procedures and soon had covered the field of almost all operations below the dia-



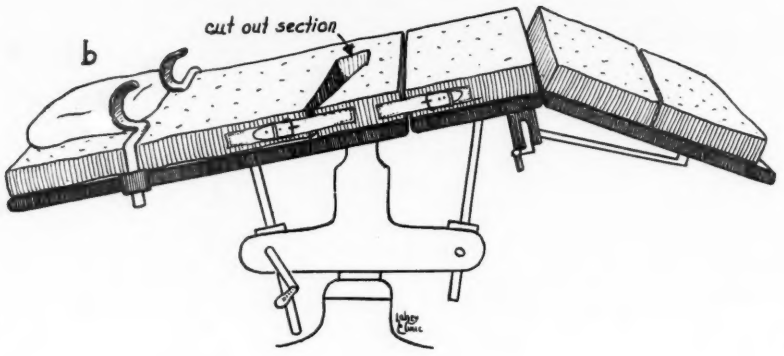


FIG. 5.

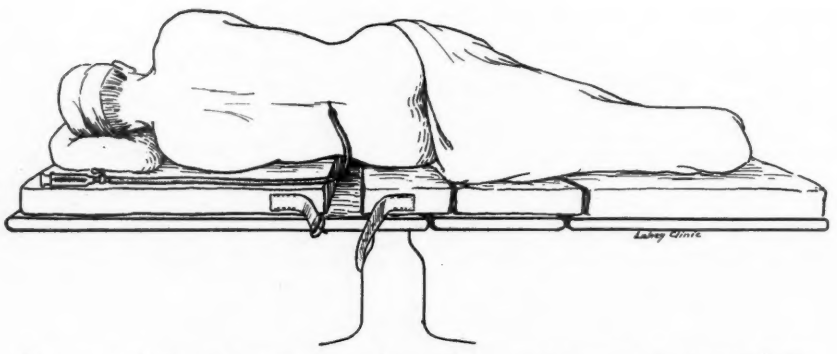


FIG. 6.

FIG. 5. a, design of mattress used for giving continuous spinal anesthesia, showing cut out section which prevents bending of the needle; b, position of mattress for operations in the Trendelenburg position.

FIG. 6. Patient in left lateral decubitus; needle in place and syringe and tubing connected.

phragm. At no time, however, have we given up our classical spinals.

Fractional spinal anesthesia may be employed without the special mattress if the patient is to be operated upon while lying on his side. The needle can be bent over and taped to the patient's back, thus allowing the drapes to be applied as usual. Many orthopedic procedures on the knee, femur and pelvis may be carried out if the patient is placed on a Bell orthopedic table so that the needle rests between two of the lumbar supports.

Our series, although admittedly small (126 cases), is representative of the type of cases for which we think fractional spinal anesthesia is particularly suitable. (Table 1.)

In our early experience with fractional spinal anesthesia,[11] satisfactory spinal puncture with the soft German silver needles was found to be difficult at times. As a result of this technical difficulty, since overcome through experience, we failed to produce satisfactory anesthesia in three cases. Now we believe that failures of the drug "to take" with this method are rarely if ever due to any individual resistance but are most often the result of faulty spinal puncture.

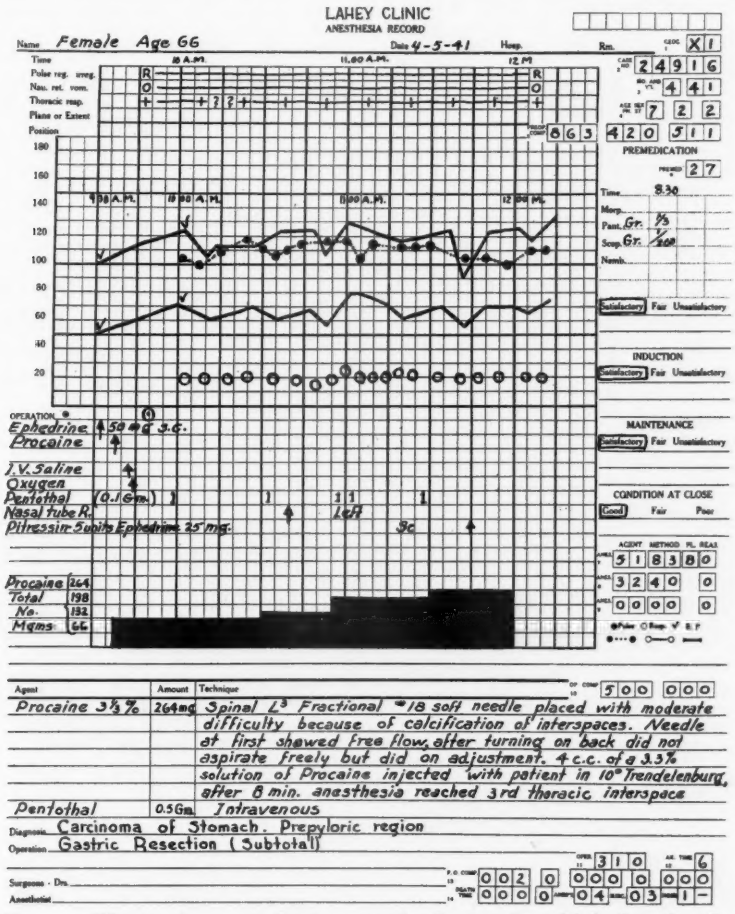

LAHEY CLINIC
ANESTHESIA RECORD
Name Female Age 66
Date 4-5-41
PREMEDICATION
Time 8.30
Morp.
Pent. Gr. 1/3
Scop. Gr. 1/200
INDUCTION
MAINTENANCE
CONDITION AT CLOSE
Good Fair Poor
Ephedrine 50 mg q 3 c.c.
Procaine
I.V. Saline
Oxygen
Pentothal (0.1 Gm.)
Nasal Tube R.
Pitressin 5 units Ephedrine 25 mg.
Left
3c
Procaine 264
Total 198
No. 132
Mgms 66
Agent | Amount | Technique
Procaine 3⅓% | 264mg | Spinal L3 Fractional #18 soft needle placed with moderate difficulty because of calcification of interspaces. Needle at first showed free flow, after turning on back did not aspirate freely but did on adjustment. 4 c.c. of a 3.3% solution of Procaine injected with patient in 10° Trendelenburg, after 8 min. anesthesia reached 3rd thoracic interspace
Pentothal | 0.5Gm. | Intravenous
Diagnosis Carcinoma of Stomach. Prepyloric region
Operation Gastric Resection (Subtotal)
Surgeons - Drs.
Anesthetist

FIG. 7. Illustrative anesthesia record of case in which fractional spinal anesthesia was employed for upper abdominal operation.

As shown in the charts (Figs. 7 and 8), with the fractional method it is generally necessary to inject 3 cc. (100 mg.) to 4 cc. (134 mg.) of a 3⅓ per cent procaine hydrochloride solution in normal saline solution with the patient in 5 to 10 degrees Trendelenburg position to establish complete abdominal anesthesia. For comparable cases, it has been our experience that the total dosage is decreased if a solution of lower concentration is used instead of the 10 per cent strength formerly advocated by

Lemmon. This has also been the observation of Ruth[12] after comparing cases, in some of which anesthesia had been obtained with 10, 5 and 2½ per cent procaine hydrochloride.

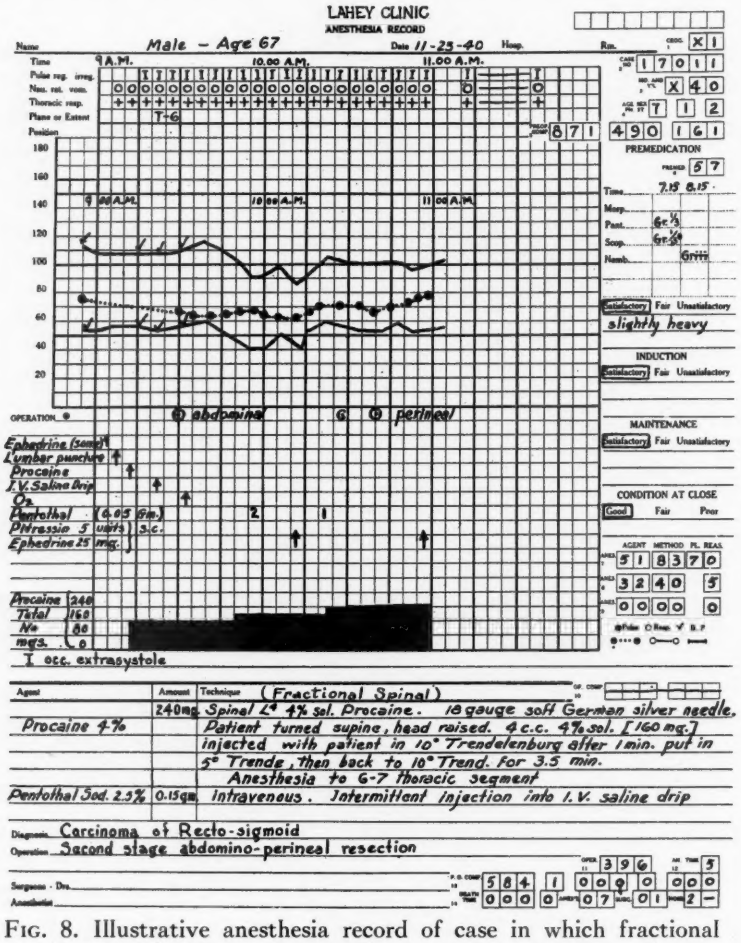


FIG. 8. Illustrative anesthesia record of case in which fractional spinal anesthesia was employed for lower abdominal operation.

The routine use of an intravenous drip placed in the great saphenous vein of the ankle as it ascends in front of the tibial malleolus has been of great help in the administration of intravenous fluids and blood transfusions during operation. This also offers a route for the administration of a supplementary intravenous anesthetic agent such as pentothal sodium to those patients who desire to be asleep or who are so restless as to hinder the surgeon.[13] Care should be taken not to inject this solution in a varicosed vein because of the danger of producing thrombophlebitis. This type of supplementary anesthesia, administered with adequate oxygen, is preferred over cyclopropane, ethylene or ether in most of our cases because it eliminates the hazards of explosion if the actual cautery or high frequency electrocoagulating unit is used during the operation.

Most of the circulatory depression not associated with hemorrhage in the cases reported occurred during the first half hour of anesthesia. An attempt is made to prevent this by the routine subcutaneous injection of 50 mg. of ephedrine sulfate before the spinal puncture is made, plus administration of intravenous saline and citrated blood when necessary. When preventative measures seem inadequate and severe hypotension ensues, the patient is placed in a 5 degree Trendelenburg position and oxygen is administered by nasal catheter or mask. The subcutaneous use of a mixture of pitressin, 5 units, and ephedrine, 25 mg., as reported by Melville[14]

experimentally in 1932 and Bourne[15] clinically in 1939, has been very helpful in treatment of this hypotension. This mixture is preferred as it does not produce the tachycardia of epinephrine or the bradycardia of neosynephrin. On many occasions after a preliminary fall in blood pressure of 20 to 30 mm. of mercury during the first half hour of anesthesia, institution of the above mentioned treatment will cause the blood pressure to return to its preoperative level and remain there for the duration of the operation, provided there is no marked blood loss.

TABLE 1

	Cases*
Subtotal gastric resection for duodenal ulcer	22
Subtotal gastric resection for cancer	12
Total gastric resection for cancer	4
Exploration and biopsy, cancer of stomach	16
Operation on gallbladder or bile duct apparatus	3
Removal of retroperitoneal tumors	3
Mikulicz resection of colon	7
Abdominoperineal resection for carcinoma of rectum	9
Abdominoperineal resection for ulcerative colitis	1
Operation on small intestine	6
Excision of tumor of mesentery	1
Resection of duodenum and head of pancreas	1
Appendectomy	2
Orthopedic operations on femur, hip, knee, pelvis	6
Dilatation and curettage followed by abdominal surgery	9
Dilatation and curettage with question of abdominal operation	6
Operation on bladder	2
Ileocolostomy	3
Gastroenterostomy	2
Repair of hernia	2
Vaginal hysterectomy	1
Superficial operation on pelvis or extremities	4
First stage Lahey abdominoperineal resection	1
Sigmoidotomy for excision of polyp	1
Posterior resection of rectum	1
Abdominal adhesions	1
Total	126

* Fifty additional cases have been done recently, but are not included because follow-up reports are incomplete.

Once anesthesia has been established with this fractional method, the anesthetist can maintain it by periodically injecting small amounts of the anesthetic agent through the tubing attached to the needle. As anesthesia wears off during an abdominal operation and sensory and motor function starts to return, the patient complains first of vague discomfort and then of pain as the abdominal muscles grow tense. Just as one would add more ether under a similar circumstance to produce relaxation during inhalation anesthesia, when this occurs during fractional spinal anesthesia we give a small dose of procaine. The addition of 35 to 50 mg. is usually sufficient. It takes from thirty seconds to three minutes for the added dose to exert its full effect. After one has had some experience with fractional spinal anesthesia it is possible to administer these additional doses at fairly regular intervals and provide the surgeon with abdominal relaxation throughout the operation.

The physiologic reason for these small subsequent doses of procaine being able to prolong nerve blocks which originally required three or four times the amount of drug to produce seems to have been partially answered by Heinbecker[16] and his co-workers (1932). Using procaine hydrochloride, "Patients were studied under low spinal anesthesia. The sequence of events was as follows: first, there was an early increase in skin temperature, after two or three minutes a loss of sensitivity to heat and cold, and then to cutaneous and pressure pains. The order of loss of these sensations was distinct, though only a brief time interval elapsed between their disappearance. Following a distinctly wider gap, loss of motor function occurred, then after another short interval, loss of joint sense, pressure sensation and touch. During recovery, the return of sensibility was in reverse order, and the gaps between the return of sensation much wider." Emmett,[17] in a study of thirty-one patients receiving procaine intraspinally, found that motor nerve block occurred last and only when the dose of the drug was fairly large. One might suppose then that these small additions of procaine in fractional spinal anesthesia provide the necessary concentration of the drug in the spinal fluid to prolong the motor block and thus prevent the reversal

of the sequence necessary for recovery, as described by Heinbecker.

These observations seem to explain why Koster,[18] using classical spinal, was able to produce a differential sensory block of sufficient height for operations about the head and neck. More recently Lemmon,[19] using fractional spinal, has been able to produce anesthesia in patients undergoing thoracic surgery and still have the muscles of respiration in an apparently normal and functioning state. On the other hand, Dogliotti,[20] also interested in the supposed difference in the response of sensory and motor fibers to local anesthetic agents, says, "We have been unable to establish a typical dilution which serves to produce a block to sensation of pain without affecting motor function. When one is able to produce an appreciable analgesia with minimal doses, that is, 0.2 to 0.3 gm. of novocain in spinal fluid, one still does not have a disappearance of the thermic and tactile sensitivity, and muscular hypotonia is already observed." Dogliotti's work has been limited to classical spinal anesthesia, however, and we must reserve our impressions regarding the possibilities with fractional spinal anesthesia until more experience can be had.

A careful postanesthetic follow-up with neurologic complications in mind has revealed but two complications of this type, and these were transitory in nature. One was a severe headache lasting five days in a patient who gave a history of headaches for fifteen years prior to operation. The second patient complained of a sciatic type of pain which began about three weeks after operation but she reports that this has since subsided. We have not had an opportunity to examine this patient as she lives in another state and has not yet returned for her second stage operation.

We are particularly interested in this method of administering spinal anesthesia as it seems more readily controllable and physiologically sound than other methods. With the fractional injection intraspinally of small doses of an anesthetic agent, we are able more nearly to approach the flexibility and control which has long been one of the outstanding advantages of the inhalation method of administering anesthetic drugs.

SUMMARY AND CONCLUSIONS

One hundred twenty-six cases are reported in which surgery was performed under fractional (continuous) spinal anesthesia. These include various types of operations below the diaphragm. Duration of the operative procedures varied in length from a few minutes to four and a half hours. Procaine, metycaine, nupercaine and pontocaine have been used as the anesthetic agent, with some minor variations in technic.

As a result of our experience, we believe that fractional spinal anesthesia is indicated in: (1) long, difficult operations such as subtotal gastric resection for ulcer, secondary operations on the biliary tract, and large bowel resections; (2) those cases of undeterminable length, such as abdominal exploration with question of gastric resection, dilatation and curettage that may be followed by hysterectomy and exploration with possible removal of retroperitoneal tumor. These indications will necessarily vary with each anesthetist and surgeon for whom the method is employed, as much depends on the type of procedure undertaken and speed of the operator.

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PEPTIC ulcers in the young may give rise to: (1) malnutrition and repeated gastric upsets; (2) exsanguinating and even fatal hemorrhage; (3) perforation into the general abdominal cavity; and (4) mechanical obstruction from cicatricial tissue near the pylorus. In general, the treatment for each of these various conditions should be much the same as that for older patients.

MALIGNANCY OF THE VULVA

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CANCER of the vulva should be readily diagnosed and if prompt treatment is instituted the end result should be most gratifying. Nevertheless, many of the patients who come for treatment present far advanced conditions. Frequently this is due to the negligence of the individual to seek early advice. Occasionally the fault lies with the medical attendant who does not recognize the early manifestations of this malady.

Cancer of the vulva comprises somewhere between 2 and 6 per cent of all cancers that occur in the female generative tract. Clark and Norris had thirty cases of vulvar cancer in 1,019 cases of genital malignancy, approximately 2.3 per cent. Schottlander and Kermauner found that between 2 and 4 per cent of genital cancers in women were located in the vulva. Dittrich states that 5.6 per cent of all carcinomas of the female genitalia are vulvar lesions. In 500 women that we have seen who had malignancy of the genital tract, seventeen occurred in the vulva, 3.4 per cent. The wide variation in the incidence of this disease compared to cancer arising in other sites in the genital tract may be due to the fact that most of the reported series of vulvar malignancies has been small.

The exact locations of the growth in our series were as follows: thirteen involved either the right or left labium and of these two also involved the clitoris. In four cases the growth apparently arose in the urethra. In many patients it is impossible to say definitely where the disease originated. In a collection by Ederle of 677 cases of vulvar cancer 109 began in the clitoris.

Our observation of cancer of the vulva coincides with that of cancer of other organs when the question of age is considered. We are seeing cancer of the cervix and cancer of the breast more frequently in younger women today than we did twenty years ago. Taussig, in a very comprehensive article, states that cancer of the vulva is a disease of old age, that 60 per cent of the patients he observed were past sixty years of age and 30 per cent were seventy or older. A study of the ages of our patients reveals a striking contrast. We had one patient in the third decade, three in the fifth, five in the sixth decade, six in the seventh and two seventy years of age or older. The youngest patient was twenty-nine, the oldest eighty-two, the average age being approximately fifty-six years.

Apparently child bearing plays but little part in the causation of this disease. Of our seventeen patients six had never borne children. The social status of the individual, however, may play some part in the causation. This probably is only a matter of personal cleanliness as the disease is seen more frequently in the lower social strata.

In five of our seventeen cases there was a family history of malignant disease. In three instances two or more of the immediate family of the patient had died of carcinoma.

Leukoplakia is a very common precurser of vulvar cancer. In fourteen cases studied by Kerns four or a little more than 25 per cent originated in leukoplakia. In our series leukoplakia apparently preceded the development of carcinoma in four cases or approximately 25 per cent. One other case may have had leukoplakia preceding the onset of her malignancy. She came under observation late in the course of her disease with a history of a bloody vaginal discharge of fifteen months' duration. She had had syphilis but had been adequately treated.

The subjective symptoms of cancer of the vulva vary considerably. In the begin-

ning there is usually itching, burning and a stinging sensation followed by the appearance of a slight discharge. Bleeding is a common early symptom. This is especially true when the growth originates in the region of the urethra. The next most common symptom is the presence of a nodule in the labium. As the disease progresses ulceration occurs and later glandular metastasis. At the time our patients were first seen there was glandular involvement in four individuals. In a fifth case the glands were enlarged but microscopic study of the excised tissue failed to reveal any cancer.

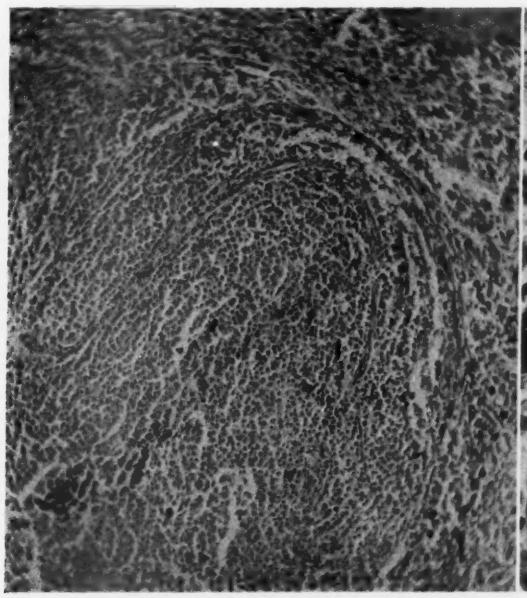

Fig. 1. A melanotic tumor arising in the skin of the labium majus. The cells are grouped in solid masses bounded by stroma. There are large dense masses of pigment.

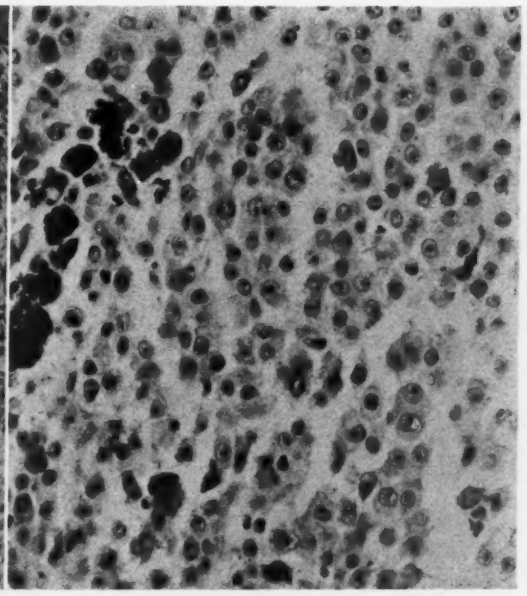

Fig. 2. Melanoma of the vulva. Cells are polygonal, a few are in mitosis. Numerous cells have many granules of melanin in the cytoplasm and there are also large, dense masses of intercellular pigment.

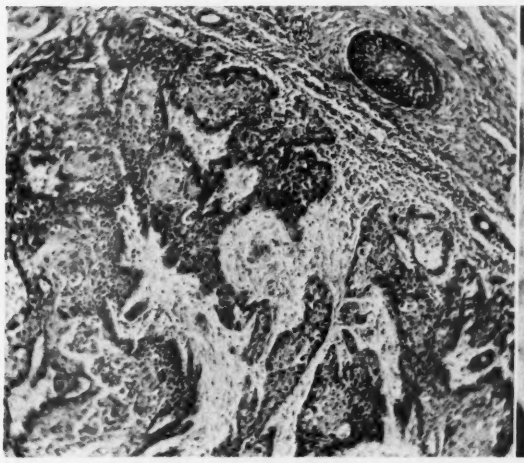

Fig. 3. Squamous cell carcinoma of the vulva. Irregularly shaped masses of squamous cells are infiltrating the corium and the subcutaneous fat. There is a moderate amount of fibrous stroma.

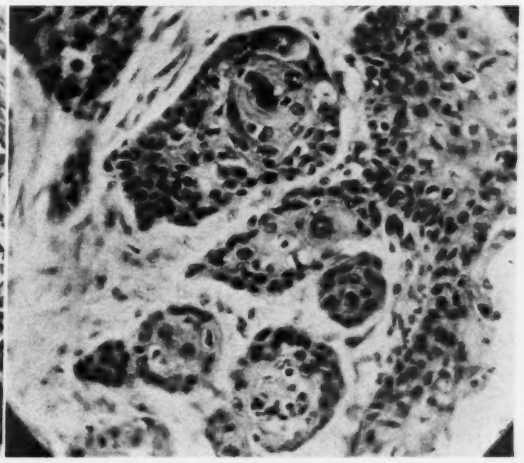

Fig. 4. Epithelial pearls are numerous; some of them have begun to break down. Cells are squamous in type, mitoses few.

PATHOLOGY

By analogy, carcinoma of the vulvar region may have its origin in any one of the

various epithelial structures found there, and reports of all of them except the sebaceous glands have appeared in the literature.

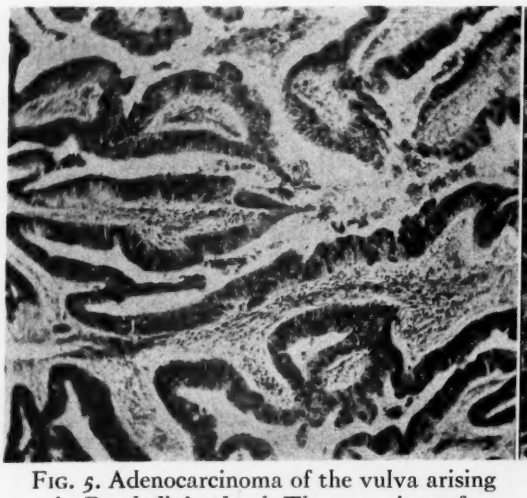

Fig. 5. Adenocarcinoma of the vulva arising in Bartholin's gland. There are imperfect glands and many papillae.

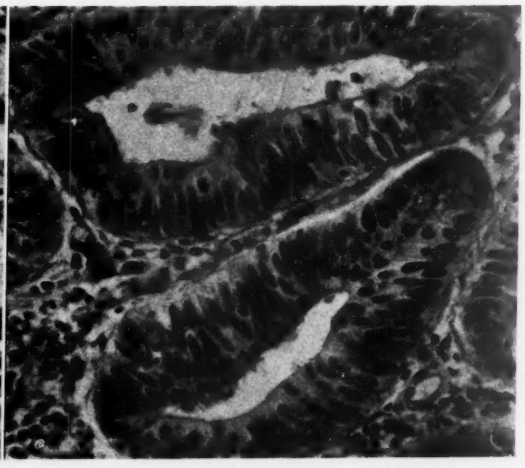

Fig. 6. The cells are columnar, multilayered and have varied polarity. Chromatin is abundant, mitoses numerous.

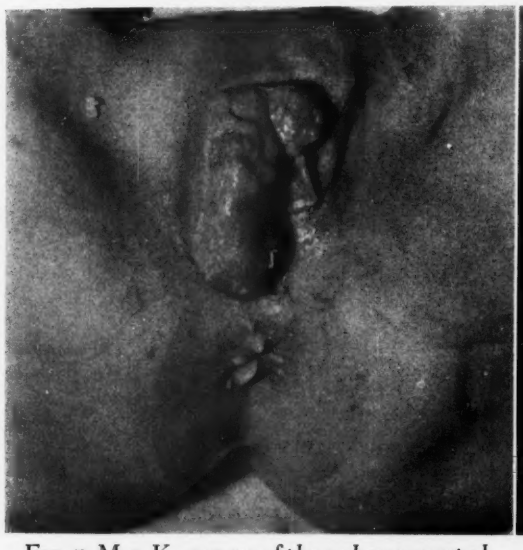

Fig. 7. Mrs. K., cancer of the vulva; operated upon in 1938; wide excision and gland dissection followed by deep *x*-ray therapy.

Fig. 8. Appearance of vulva two years after treatment. Vagina admits one finger. Figures 9 and 10 show microscopic appearance of excised tissue.

The mucosa of the labium majus, and minus, the clitoris, the urethra, and the surface covering of the skin of the labium majus give rise to squamous cell tumors. From the sweat glands and Bartholin's glands tumors with gland like structures made up of their characteristic cells develop. Melanin bearing cells, probably of nerve cell origin, in the skin of the labium majus produce the melanosis. These tumors do not have the structures of squamous cell tumors and their genesis is still in doubt.

Pre-existing and associated pathology consists of leukoplakia, kraurosis, mild inflammation from pruritis, syphilis and psoriasis.

The squamous cell tumors are of three types grossly: (1) warty, or papillary, (2) ulcerative, and (3) diffuse infiltrations. The glandular tumors appear as deeper tumefactions. The pigmented tumor may be preceded by a colored "mole."

Malignancy of the vulva is usually high grade in a larger proportion than in similar

tumors elsewhere in the body. Metastasis occurs as a rule in the lymph-nodes of the groin, and locally about the primary tumor, in the abdominal wall, about the anus, and the skin of the thighs. Late in the course of the disease and in the more malignant instances, the postperitoneal lymph-nodes and all viscera of the trunk may be affected.

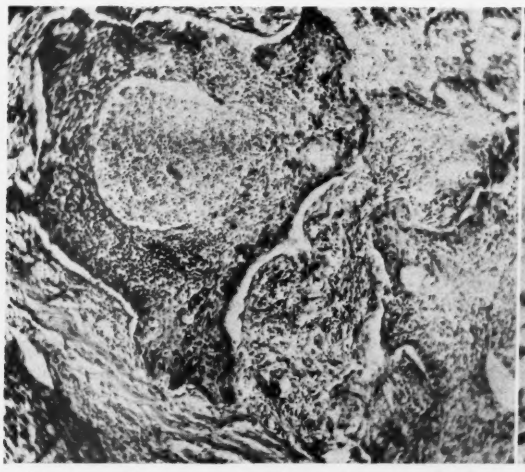

Fig. 9. Squamous cell carcinoma of the vulva. Large epithelial masses with necrotic centers are infiltrating the subcutaneous tissue. In the stroma is a moderate inflammatory reaction.

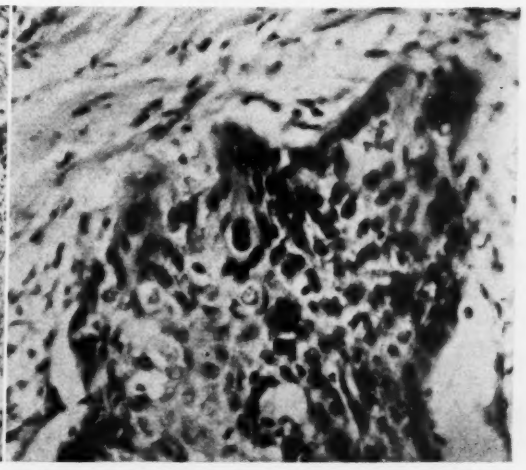

Fig. 10. Cells are squamous in type with irregular morphology.

In our series there was one melanosarcoma, one adenocarcinoma arising in Bartholin's glands and fifteen squamous cell cancers, an incident of the latter of 88 per cent.

TREATMENT

Cancer of the vulva resembles in many respects cancer of the lip. Both spring from a transitional type of pavement epithelium. They tend to remain local for some time. In some cases the lesion is but slightly elevated and rather soft, others are firm, infiltrative and ulcerate early. As in the treatment of early lesions on the lip radium may be used to great advantage so also may it be used in similar types of cancer of the vulva. Radium alone should not be used in the infiltrative or deeply ulcerated type of growth. We do think that in the treatment of early cancer of the vulva in the aged or debilitated patient radium has a definite place. Also in early cancers seen in younger women simple local excision followed by radiation therapy gives good results and obviates the mutilation incident to the wide removal of vulvar structures.

Radium is extremely valuable in the treatment of cancer arising in the urethral area. In this location wide excision is frequently followed by incontinence of urine. It is our practice to excise enough tissue for microscopic study and then thoroughly burn the growth with the electric cautery and later treat by local application of radium. The usual dose of radium we employ is 600 mg. hr. filtered through 1 mm. of brass and two layers of rubber dam. This can be repeated in six weeks if necessary.

Surgery is the treatment of choice in most cancers of the vulva. In the nodular type of lesion, the melanoma or the deeply ulcerated growth the excision should extend well beyond the involved area. This wide excision should be combined with the removal of the regional lymph-nodes. Frequently the nodes are found enlarged and palpable and yet not invaded by cancer. If the glands of the inguinal region are cancerous, the dissection should include not only the lymphatics of Scarpa's triangle but in

addition those within the inguinal and femoral canals.

In the more advanced cases of vulvar cancer, surgery should be supplemented by intensive deep *x*-ray therapy. Postoperative irradiation should also be employed in all cases in which the pathological gradation of the tumor is three or four. In one of our cases in which the growth had extended beneath the ramus of the pubic bone, wide excision and glandular dissection were combined with implantation of radium needles into the involved tissue. Each needle contained 2½ mg. of radium filtered through ½ mm. of platinum irradium. They were spaced 1½ cm. apart and allowed to remain six days. (Figs. 5 and 6.) Later intensive deep *x*-ray therapy was employed. This patient is alive five and one-half years since treatment was completed.

RESULTS

Of the seventeen cases studied one could not be traced. Six patients are dead of their disease. Of these six patients one was a girl of twenty-nine years of age who had in addition to her vulvar cancer a papillary cyst adenoma of the left ovary. The cause of her death is not known but was probably due to cancer. One patient died of generalized metastases eighteen months after the removal of a malignant melanoma of the left labium. (Figs. 1 and 2.) Of the other four cases the disease had been present six months to two years before any treatment was instituted and in two there was wide spread, glandular involvement at the time the patients were first seen. One patient, aged seventy, lived four years following treatment and died of a recurrence.

Ten patients are alive and well, one for eleven years, one for eight and one-half years (Figs. 3 and 4), one for eight years, one for seven years and another for five and one-half years. (Figs. 5 and 6.) Of the five patients treated less than five years ago one is well four years and two are well and free of the disease two years since treatment. One is well eighteen months and the other, whose therapy on account of her advanced age and general condition consisted only of radium, is now living sixteen months since treatment. These figures show a five-year curability of cancer of the vulva of approximately 30 per cent.

SUMMARY

The incidence of vulvar cancer as compared to cancer elsewhere in the female generative tract is presented.

The age incidence is less than some observers have reported.

The pathology of the lesion is discussed. Eighty-eight per cent are squamous cell cancer.

A method of treatment is outlined and the value of radium therapy in certain types of lesions is emphasized.

The five year curability of vulvar cancer is about 30 per cent.

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SURGERY IN PATIENTS OVER FIFTY WITH OBSTRUCTING PYLORIC LESIONS

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PYLORIC obstruction in adults past fifty is commonly considered to be due to either a malignant growth within the stomach or one arising adjacent to it and blocking the orifice. On account of their age and generally poor health these patients are considered poor operative risks and are seldom advised to submit to even an exploratory laparotomy.

However, it is to be remembered that in spite of the clinical symptoms and even examination of the pyloric mass at an exploratory laparotomy leading one to believe the condition to be a malignant one, the obstruction may occasionally be the result of an inflammatory process around an old ulcer. Consequently startling improvement may be obtained in some of these patients following a so-called palliative gastroenterostomy.

During the past few years I have had a small group of cases that bring out this point and although considered bad risks to start with, have come through their operation and postoperative course very well. In presenting them it is with the hope that other surgeons will operate upon similar patients with a little more enthusiasm.

The series was made up of eight patients, two female and six males, the youngest fifty-one and the oldest seventy-four. Most of them gave only a comparatively short history of pain, indigestion, loss of weight, etc. Some had severe complications, one was a severe diabetic, one was a cardionephritic with diabetes, another was said to have spinal lues and still another had a chronic asthmatic cough. In spite of these complications they all survived their operative procedures.

Their case histories briefly summarized follow:

CASE I. Mrs. G. P., sixty years old, married, had been well up to several years ago when she began to have pains in the pit of her stomach, gastric upsets and belching. *X*-ray at that time revealed a nonfunctioning gallbladder and what was suspected to be a distorted duodenum. She was placed on a diet and improved for a while. Later her symptoms returned, accompanied by severe pain after eating. She began to vomit and as a result was afraid to eat and lost a good deal of weight. *X*-rays were taken again showing a definite pyloric stenosis with a duodenal ulcer. She finally consented to operation and was found to have a mass of adhesions about a thickened gallbladder which was also adherent to the duodenum. The pylorus was narrowed to a very small opening as a result of these adhesions and there was a cicatrizing ulcer in the first portion of the duodenum. A cholecystectomy and posterior gastrojejunostomy were done. The patient stood the procedure well and left the hospital in about two weeks. Up to the present she feels well, is eating a full diet and has no gastric discomfort.

CASE II. Mr. P. P., fifty-nine years of age, gave a history of pain in the pit of his stomach, loss of weight and inability to swallow food.

Up to April, 1939, the patient had always been active and in good health. He then suddenly noticed that he had polypuria, thirst and a ravenous appetite. He was examined and found to be a severe diabetic. He improved somewhat and went to Europe for several months but on his return at the beginning of September his diabetes was not under control and he was losing weight. In spite of therapeutic measures he continued to lose weight and found that he could not retain food. He began to have epigastric pain and to regurgitate undigested food once or twice a week. *X*-rays taken at the end of September showed complete pyloric obstruction with marked gastric dilatation. In spite of repeated washings, the patient did not improve and became so dehydrated that he was admitted to Wickersham

Hospital. There he was given large doses of insulin, blood transfusions and as he improved a good deal he was explored. A large obstructing mass was found at the pylorus with an edematous dilated stomach. A quick posterior gastrojejunostomy was done and he stood the shock of the operation very well and left the hospital two weeks later with blood sugar of 122 mg. Since then he has been able to eat fairly well but his diabetes is still a problem He has, however, gained twenty-four pounds since the operation.

Case III. Mr. L. D., fifty-one years of age, was referred by Dr. Bassler. He suffered with pain in the epigastrium, nausea and vomiting. The patient had had a cholecystectomy two years previous since which time he had had epigastric pain. This had no relation to meals or type of food eaten. His attacks of vomiting brought up dark brown material but no blood. He claimed he had not lost weight but his family said he had. *X*-rays showed a definite pyloric obstruction. Repeated gastric lavages showed complete retention and consequently because of the persistent pain he was considered a case of gastric carcinoma.

Laparotomy on April 8, 1939 revealed a mass of omental adhesions to the old gallbladder scar. Further exploration revealed a tumor mass the size of an orange at the pyloric end of the stomach firmly adherent to the gallbladder bed and to the pancreas. The stomach itself was dilated and somewhat edematous.

As there was no way to free the tumor a simple posterior gastrojejunostomy was done. He had an uneventful postoperative course and went home two weeks later. He has since returned to work as a fire captain, eats well and has no pain.

Case IV. Mrs. E. M., fifty-one years of age, was referred by Dr. Spencer. She had been vomiting and bringing up blood for a month. The patient had been vomiting immediately after eating for several weeks and at times it was accompanied by bright blood. She had pain after eating for several years which usually was relieved by alkalies.

The past history revealed that the patient always had indigestion and had been in hospitals for the same trouble. She had lost a good deal of weight lately, now being only 110 pounds. Gastric analysis showed the presence of free hydrochloric acid, no blood but traces of bile. *X*-rays showed an indurated ulcer of the lesser curvature of stomach probably malignant with partial pyloric obstruction.

Operation on September 15, 1939, showed a chronic gastric ulcer on the lesser curvature with pyloric obstruction, adhesive perisplenitis and calcified mesenteric lymph-nodes. A subtotal gastrectomy and an anterior gastrojejunostomy were done and the calcified lymph-nodes removed.

She had a stormy postoperative course regurgitating her food for over ten days. She was kept going by continuous intravenous glucose infusions and finally straightened out. Her wound nearly disrupted but eventually healed solid and she left the hospital in good shape. At present she weighs 123 pounds and eats nearly everything without discomfort.

Case V. Mr. L. M., seventy-four years old, was referred by Dr. Lardaro. He had had periodic attacks of severe pains, nausea, vomiting and weakness.

Patient gave a long history of attacks of abdominal pains. He had been known to have had a peptic ulcer for at least twenty years and for the last ten years had had symptoms of pyloric obstruction. In 1936, *X*-rays showed nearly complete pyloric obstruction. At that time the symptoms were relieved by gastric lavages and sedatives. For the last six months he had been losing weight, had not been able to eat and had had constant epigastric pain. He also vomited large quantities of food at times. On admission at Misericordia Hospital gastric lavages brought back over thirty-two ounces of foul smelling fluid. Repeated washings always showed retention. *X*-rays revealed a marked gastric dilatation with complete pyloric stenosis.

He was operated upon February 23, 1940 and a mass of omental adhesions was found between the anterior abdominal wall, the liver and gallbladder. There was evidence of a plastic peritonitis about the right lobe of the liver. The gallbladder itself was not very thick but about three times the normal size. On further exploration a large mass was found envolving the pylorus, first portion of the duodenum adherent to the liver and pancreas. No palpable nodes were felt.

After division of the adhesions, the gallbladder was removed and as the pyloric mass was firmly fixed a simple posterior gastrojejunostomy was done. Pathological report was chronic cholecystitis.

He developed a postoperative pneumonia but this cleared up in a few days. His sutures were removed on the twelfth day, the wound healed well and he went home on the sixteenth day. He has since been very comfortable, regaining his normal weight.

Case vi. Mr. G. L., fifty-seven years old, was referred by Dr. J. Lauricella. He had had pain in the pit of the stomach, radiating then to the back. The patient had had symptoms of indigestion for several years and lately had not been able to retain food. Pain was constant and he had lost a great deal of weight and had become jaundiced.

Past history revealed no previous operations; he was married and had several children. He is said to have contracted lues many years ago and had developed symptoms of locomotor ataxia. He did have a positive spinal Wassermann test but following a long course of treatment it became negative. Stools were nearly clay colored.

He was a small, somewhat emaciated, jaundiced individual walking with an ataxic gait. Abdominal palpation revealed a sensation of a mass in the midepigastrum.

Laparotomy revealed a hard nodular mass involving the pylorus, base of gallbladder and head of pancreas. The gallbladder itself was markedly distended with bile. As a palliative procedure it was decided to do a cholecystgastrostomy and a posterior gastrojejunostomy. This was done at one operation and the patient stood the procedure very well, as a matter of fact he did not regurgitate any bile or fluid through the Levine tube. He rallied very quickly and went home in a little over two weeks with no biliary drainage. He has slowly been able to regain his appetite, has gained eight pounds in weight and his jaundice has cleared up.

Case vii. Mr. DeM., sixty years old, was referred by Dr. Constantine. The patient was admitted to Parkway Hospital on January 20, 1939, with a story of marked loss of weight and weakness but only two weeks' history of pain in the right side of abdomen. For the last week he had not been able to retain any food and would occasionally vomit a clear mucoid fluid.

His previous history was negative for any serious illness but he was known to be a diabetic for the past eight years. On admission physical examination revealed a man with a large frame who apparently had lost a good deal of flesh. Hemoglobin 40 per cent; red blood cells 2,290,000 and 4,100 white blood cells. Urine showed traces of albumen and sugar and many hyaline and granular casts; blood sugar 148 mg., gastric analysis showed free hydrochloric acid 28, total acidity 88; stool showed traces of blood; blood pressure 180/70. Barium enema showed no evidence of malignancy. *X*-ray of stomach showed a complete pyloric obstruction probably due to a malignancy.

His general condition improved with medication, infusions and transfusions but he could not retain anything in his stomach. It was then decided to perform on exploratory operation and this was done on February 14, 1939, about four weeks after admission. At operation a slight amount of serosanguineous fluid was found in the cavity. The first portion of the duodenum was covered over by plastic adhesions. The duodenum itself seemed fused to the head of the pancreas into one mass and the pancreas itself was hard and nodular. The stomach itself was extremely edematous. A tentative diagnosis of neoplasm of the head of the pancreas was made. As a palliative measure a posterior gastrojejunostomy was done. There was no reaction. The patient very shortly began to take food by mouth and quickly grew stronger. In spite of our fear of a disrupted wound he healed solidly and went home about three weeks after the operation. He has since been examined repeatedly and at present, eighteen months later, has gained twenty-one pounds and has no difficulty with his digestion.

Case viii. Mr. J. A., seventy years of age, on November 2, 1939, gave a history of vague abdominal pains and periodical attacks of vomiting which were present for four months.

This man was in good health, except for a chronic asthma, up to four months ago when he began to have abdominal pains particularly after eating. This grew worse and he lost his appetite. *X*-ray show complete pyloric stenosis with marked gastric retention. Gastric lavages showed retention, traces of blood but free hydrochloric acid. He was a difficult case to handle as he was very unco-operative. Following a 500 cc. transfusion of whole blood he was explored on November 6, 1939. He was found to have a large indurated mass on the lesser curvature of the stomach extending into the pylorus and obstructing it. The gastrohepatic omentum was congested and there were

several hard lymph-nodes present. The liver appeared normal.

In view of the age of the patient no radical surgery was considered, only a posterior gastrojejunostomy being done. Following the operation he developed a congestion at both bases and a nasty productive cough but all the signs cleared up and he left the hospital on the sixteenth day with the wound almost completely healed. He at present is eating a full diet without discomort and his wound is solid.

Before taking up for discussion some points brought out in this small but interesting group of cases we wish to repeat that for the sake of brevity the case reports were made as short as possible, but that in every respect the cases were completely worked up before operation and carefully followed up to the present time. No biopsies were done because at the time of the operation either the mass was considered definitely malignant or there was fear of starting uncontrollable bleeding.

COMMENT

It may be noted, first, that in many of the patients the symptoms of pain, indigestion, loss of weight, etc., were all of short duration. Where they had been present for some time, there seemed to be a definite change, the patient rapidly losing weight and showing definite signs of pyloric occlusion.

Second, in all the *x*-ray studies the obstruction at the pylorus seemed to be nearly complete accompanied by marked gastric retention. This was interpreted as showing that the lesion was of long standing and probably malignant.

Third, six cases at operation were believed to be infiltrating growths at the pylorus, not resectable in view of the extension into the surrounding organs. The seventh was considered definitely a pyloric ulcer but the eighth case, in which a subtotal gastrectomy was done, was also suspected to be a malignant degeneration in an ulcer on the lesser curvature.

Fourth, besides a posterior gastrojejunostomy it was found necessary to do a cholecystectomy in two and a cholecystgastrostomy in another on account of dense adhesions involving the gallbladders and the obstruction of the bile ducts causing severe jaundice in the third.

Fifth, in spite of being over fifty and most of them suffering from other diseases: diabetes, asthma, hypertension, etc., the patients were all able to withstand major surgical procedures, recover from the operation, regain their strength, be able to eat almost all foods and put on quite a few pounds in weight. I believe this result was obtained by careful preoperative study and preparation, regulation of their diabetes, prolonged bedrest, and the administration of adequate amounts of fluids, blood, etc., before and after the surgical procedure.

CONCLUSION

Pyloric obstruction in patients past middle life is not always caused by a malignant growth. In spite of a relative short history the condition may be the result of an inflammatory process about an old gastric or duodenal ulcer.

Even though the clinical symptoms and roentgenological findings point to a neoplasm, an exploratory laparotomy is justifiable.

With proper preparation these patients withstand major surgical procedures well and remarkably good results may be obtained.

THE TREATMENT OF LARGE HYDROCELES BY INJECTION OF SODIUM MORRHUATE*

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WITH the exception of epididymitis, hydrocele is the most frequently encountered tumor of the scrotum. It is an abnormal accumulation of serous fluid between the two layers of the tunica vaginalis testis. Normally, a few drops of fluid are present within this cavity and serve to moisten its surfaces.

The serous lining of the hydrocele sac is derived from the saccus vaginalis of the peritoneum, which preceded the descent of the testis from the abdomen into the scrotum. The testis and epididymis are invaginated by this membrane. It may be described as consisting of a visceral and a parietal layer; the potential space between these two layers forms the hydrocele pouch. After the descent of the saccus vaginalis that portion which extends from the peritoneum to just proximal to the head of the epididymis becomes obliterated. In the adult, the tunica vaginalis alone persists so that hydrocele of this portion of the saccus vaginalis is the type usually encountered. The obliterated portion of the saccus vaginalis can often be seen lying in the loose areolar tissue that surrounds the spermatic cord. If this portion of the saccus vaginalis does not become obliterated throughout its course from the abdomen to near the head of the epididymus, a variety of congenital abnormalities results, particularly hydrocele and hernia.

Hydroceles may be classified according to their location, as congenital, infantile, ordinary, hydrocele of the cord and hydrocele of the hernial sac. (Figs. 1, 2 and 3.) Classified as to etiology, hydroceles are divided into congenital, acquired and idiopathic. Congenital indicates that the condition was present at birth; acquired, that the etiological factor was some disease or trauma of the scrotal contents; and idiopathic, those of indefinite origin. The vast majority of hydroceles are acquired and originate as a complication of injury or disease of the scrotal contents. Those that are due to injury or disease are also classified as symptomatic or secondary hydroceles. The symptomatic hydrocele may be acute or chronic, depending upon the primary scrotal lesion. The idiopathic hydrocele is always of the chronic type, slow in its development and the etiological factor impossible to determine.

If the history alone is used as the basis of classification, the majority of hydroceles will fall in the idiopathic group, because patients frequently are unable to recall any injury or disease that could account for the hydrocele. Fluid does not collect in abnormal amounts in other normal serous cavities, then why should it collect in the tunica vaginalis unless some antecedent injury or disease was responsible. Careful examination of the epididymis at the time of operation will in practically every instance, except in the congenital type, reveal cicatrical tissue, adhesions and thickening. This indicates that some inflammatory process preceded the hydrocele. Mild asymptomatic epididymitis is of more frequent occurrence than is generally recognized and is probably the predisposing cause of idiopathic hydrocele. The epididymitis may have been so mild that it passed unnoticed or was forgotten. Any inflammatory process of the tunica, primary, or secondary, from either the testis or epididymis, is followed by the secretion of serum into its cavity, absorption is limited and a hydrocele results. The low specific

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gravity and serum content of the transudate indicate that hydrocele fluid is an inflammatory exudate. Those that do not hold with this theory ask, Why does not hydrocele follow acute epididymitis in a higher percentage of cases? In acute epididymitis the inflammatory reaction is so marked that the serous layer of the tunica vaginalis is destroyed, or becomes so sclerosed and thickened that it prevents the secretion of serum and the formation of a hydrocele.

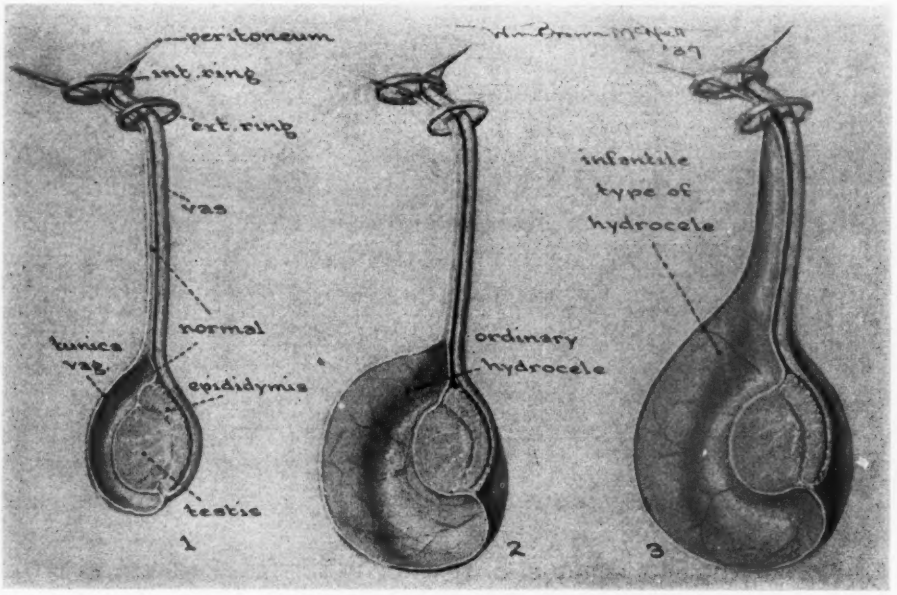

Fig. 1. Schematic drawing showing: (1) normal relationship of tunica vaginalis testis; (2) simple vaginal hydrocele; (3) infantile hydrocele, the frequent variety. (Greene. *Am. J. Surg.*, April, 1937.) (Herman. The Practice of Urology. Philadelphia, 1938. W. B. Saunders Co.)

Congenital hydrocele is the type usually observed in the young. Campbell[1] in the examination of seventeen boys under six years of age with hydrocele, found that the condition had existed since birth in thirteen. Vallery-Radot, Vaglio, and Sales[2] believe that congenital syphilis is one of the chief predisposing factors in congenital hydrocele. In 115 cases of congenital syphilis examined by them 20 per cent had hydrocele, and in fifty-five congenital hydroceles, 40 per cent had congenital syphilis.

Campbell[3] in a review of 306,387 admissions to Bellevue Hospital during a seven-year period, found 502 hydroceles in 446 patients. Fifteen were congenital in origin and ten of these were in infants. Of the 306,387 admissions, 187,963 were males and 12,274 were admitted to the urologic service. Four hundred forty of the urologic admissions complained of hydrocele. This represented 3.6 per cent of the urologic admissions and .24 of the male admissions, or 1 in 400. Ninety per cent of these were over twenty-one years of age. There was a slight predilection for the right side: 50.2 per cent on the right and 41 per cent on the left, and bilateral involvement was present in the remainder.

Uninfected hydrocele fluid resembles blood serum; the specific gravity varies from 1.020 to 1.026. If infection has taken place, the fluid has a hazy or cloudy appearance due to leukocytes and bacteria. If there has been recent intratunical hemorrhage, the color of the fluid will vary from pink to a deep red. A brownish dirty fluid indicates an old hemorrhage.

The normal tunica vaginalis is thin and pale in color. In acute inflammatory conditions it is red, injected and edematous. If the hydrocele is of long duration and has been subjected to frequent tappings or

inflammatory reactions, the tunica will be greatly thickened and at times almost cartilaginous in nature. On rare instances, a chronic pyogenic disease is to be differentiated from idiopathic hydrocele and the co-existing pathology diagnosed. Bilateral

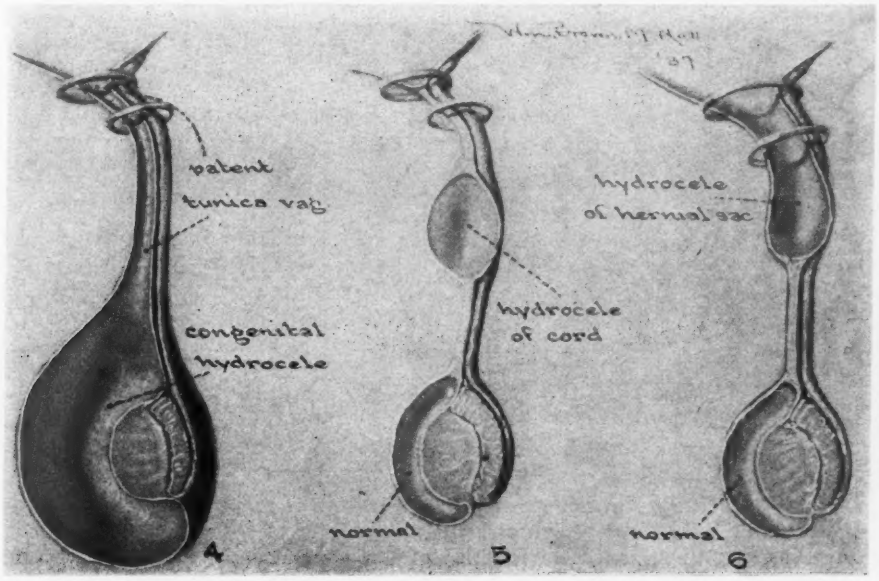

Fig. 2. (4) Congenital hydrocele; (5) hydrocele (encysted) of the cord; (6) congenital funicular hydrocele. (Greene. *Am. J. Surg.*, April, 1937.) (Herman. The Practice of Urology. Philadelphia, 1938. W. B. Saunders Co.)

hydrocele is encountered in which calcification of the tunica vaginalis has taken place. The majority of hydroceles contain only one cavity, occasionally the multilocular type is encountered.

The symptoms in chronic hydrocele are few. There is present a unilateral painless enlargement of the scrotum. The enlargement develops slowly and frequently the date of the onset is unknown. It is not uncommon for a patient with a hydrocele that contains from two to four ounces of fluid, to insist that it developed overnight, without there being present any acute condition to account for its presence. Here the enlargement had developed slowly and had passed unnoticed until it was discovered during bathing or dressing, or was noted by someone else. The large hydrocele may produce a dragging down sensation in the inguinal region due to its weight. At times, the only complaint may be that it produces a noticeable bulge or interferes with sexual relations.

Chronic symptomatic hydrocele due to neoplasm, tuberculosis, syphilis or other chronic hydrocele in the adult may be due to syphilis or tuberculosis. Those due to syphilis frequently disappear when antiluetic therapy is instituted.

In acute hydrocele, pain and swelling are the chief symptoms. The scrotal wall is thickened and presents evidence of an acute inflammatory reaction. The pain is due to pressure produced by the rapid accumulation of fluid in the acutely inflamed tunica or to the underlying pathologic condition. The pain may be referred to the inguinal region or the lower quadrant of the abdomen due to the presence of an acute vasitis or seminal vesiculitis. Acute hydrocele is always secondary to an inflammatory condition of the testis or epididymis, or results from trauma.

A smooth, painless, pear-shaped scrotal tumor that can not be reduced is usually a hydrocele. The hydrocele sac tapers towards the inguinal region and the cord can be palpated above it. A cough impulse is obtained only when the hydrocele is complicated by a hernia. In congenital hydrocele there is a direct communication be-

tween the tunica vaginalis and peritoneal cavity. It is the only type that is reducible. The opening into the peritoneal cavity may be so small that pressure fails to produce an immediate reduction in the size of the tumor. In the young, it is advisable to compare the early morning and afternoon size of the scrotum. Through a small opening, the fluid may empty into the peritoneal cavity during the recumbent position of sleep.

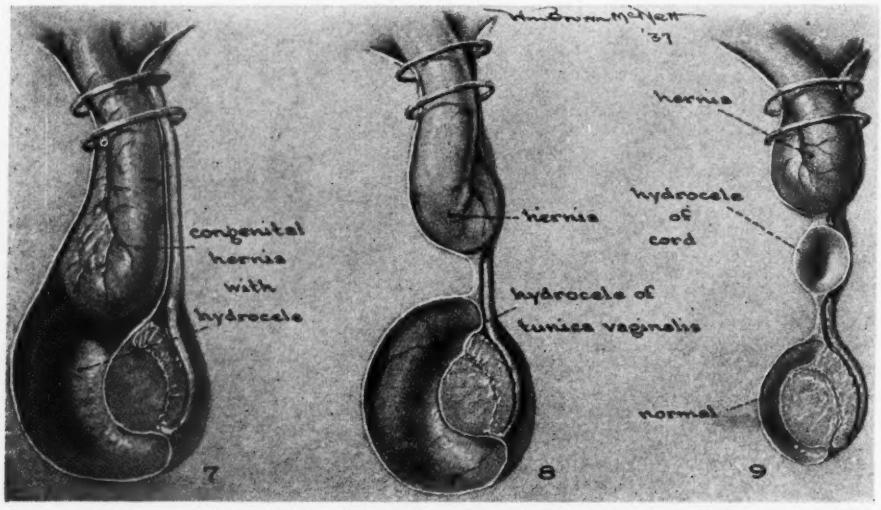

FIG. 3. (7) Congenital hernia with hydrocele; (8) simple (vaginal) hydrocele with incomplete hernia; (9) hernia and hydrocele of cord. (Greene. *Am. J. Surg.*, April, 1937.) (Herman. The Practice of Urology. Philadelphia, 1938. W. B. Saunders Co.)

Hydrocele must be differentiated from hernia, varicocele, spermatocele and hematocele. It is not always possible to determine if the scrotal enlargement is due in its entirety to a hydrocele. In most instances the diagnosis can be made by transillumination. Thickening of the tunica and marked turbidity of the fluid due to pus, bacteria or hemorrhage may prevent or diminish the translucency. In infants, due to the thinness of the underlying structures transillumination of a hernia is possible.

Hernia gives an impulse on coughing, and is usually reducible, or a history is obtained of its having been reducible. A varicocele diminishes in size when the patient is in the recumbent position. Scrotal edema, due to cardiovascular disease, may be mistaken for hydrocele. It frequently will transilluminate, but there is present the characteristic pitting edema. Spermatocele is seldom encountered, is usually smaller than hydrocele and the testis is in front and below the sac, whereas in hydrocele it is behind. Spermatocele usually does not transilluminate. In acute hematocele there is a history of recent trauma. Trauma to a chronic hydrocele may be followed by hemorrhage that prevents transillumination.

The transillumination should be done in a darkened room with a brilliant small, beam light. The fountain pen flash-light is ideal for this examination. If an ordinary light is employed, the scrotum should be viewed through a paper cylinder.

The history, examination and transillumination ordinarily establish the diagnosis of hydrocele. The position of the testicle is determined by transillumination and palpation is a most valuable aid in the diagnosis. A shadow in the lower posterior portion of the pink cysts, produced by the transillumination, represents the testicle and confirms the diagnosis. If a neoplasm or co-existing pathological condition of the testicle is suspected, tapping greatly facilitates the examination. Tapping is contraindicated in the absence of light transmission.

Hydrocele, unless complicated by hernia, neoplasm, tuberculosis or other disease, is never dangerous to life. Suppuration and hematocele do not occur in the idiopathic

hydrocele except as the sequela of tapping or trauma, but may occur in those due to neoplasms, tuberculosis and syphilis.

must be employed to prevent infection. It may be utilized with safety and the assurance of good results in the simple chronic

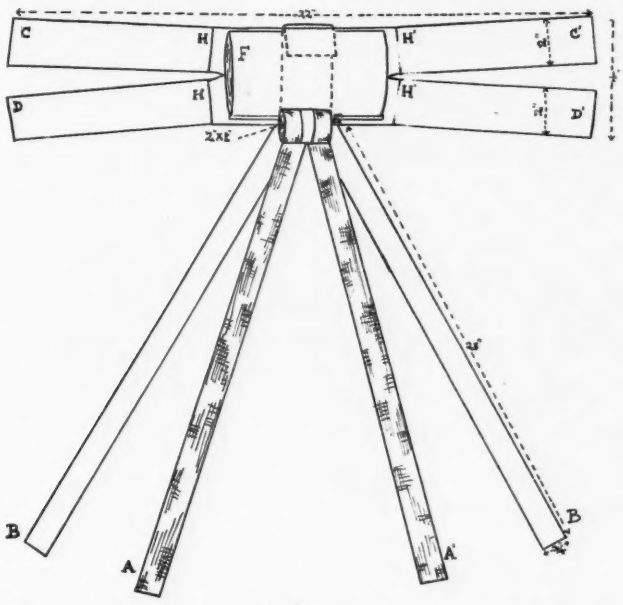

Fig. 4. A sketch of modified Bellevue adhesive suspensory with dimensions.

TREATMENT

There are three recognized forms of treatment in hydrocele: tapping, injection, and surgery.

Tapping as a method of treatment should be employed only in infants and young children. In this group, it frequently is curative and should be given a trial before more radical measures are advised. In the adult it is rarely curative and gives only temporary relief.

The injection treatment of hydrocele was frequently employed forty years ago. Iodine and carbolic acid were the original solutions used for injection. With the perfection of operative procedures, the injection treatment was discarded because of the uncertain results, infection, necrosis and local reaction that at times necessitated an orchidectomy. In recent years several authors have reported excellent results in the injection treatment of hydrocele, employing the solutions used in the injection treatment of varicose veins.

Injection treatment is an office procedure, but unquestionable sterile technic

hydrocele. One of the principal objections to this form of treatment is the possibility of overlooking co-existent pathological conditions. The history, examination of fluid, and palpation of the testis following aspiration should reduce to a minimum this error. If the aspirated fluid is bloody, or contains pus and bacteria, injection is contraindicated.

The scrotum should be shaved and scrubbed with soap and water preceding the injection. Two areas in the scrotum wall that transilluminate and are relatively free of large blood vessels are selected. These areas are infiltrated with novocain. A No. 18 to 20 gauge needle is inserted through the anesthetized skin and pushed for one-half inch through the subcutaneous tissue and then plunged into the hydrocele sac. This method of inserting the needle prevents leakage of the sclerosing solution through the scrotal wall. A smaller needle is inserted into the other anesthetized area in the same manner. This aids in the aspiration of the fluid as it destroys the negative pressure. The fluid is withdrawn,

and sufficient 2 per cent novocain solution is injected through the large needle to distend slightly the sac and to surround the testicle completely. The novocain reduces the pain from the sclerosing solution. It is permitted to remain in the cavity for ten minutes. Following its aspiration, 3. cc. of 5 per cent sodium morrhuate with benzyl alcohol is injected into the hydrocele sac. The needles are withdrawn and the scrotum massaged to secure an even distribution of the solution through the cavity. A modified Bellevue adhesive suspensory (Figs. 4, 5 and 6) is applied and the patient ordered to remain in bed for two days. If pain follows the treatment, a mild narcotic is prescribed. There is usually a moderate amount of swelling of the scrotum and a reaccumulation of fluid in from seven to ten days. The pain, swelling and reaccumulation of fluid is restricted by the use of the modified Bellevue adhesive suspensory. Aspiration is indicated when sufficient fluid has reaccumulated to distend the tunica. This fluid has a hazy appearance and contains fibrin and leukocytes. If there is a second reaccumulation of serum, the injection is repeated. By using small amounts of sodium morrhuate and repeating the injection when indicated, satisfactory results with a minimum of reaction will be obtained. A second treatment may be avoided by utilizing a larger amount of sodium morrhuate at the original injection but this will increase the reaction. The purpose of the injection is to produce sufficient inflammatory reaction to destroy the secreting surface of the serous membrane and to obliterate the sac.

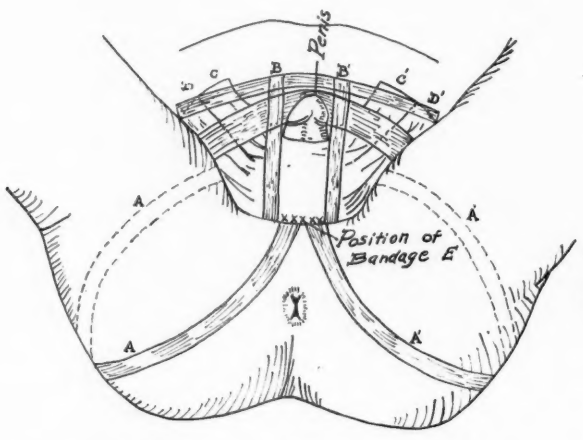

Fig. 5. Perineal view of patient with suspensory applied; scrotum compressed and elevated by suspensory.

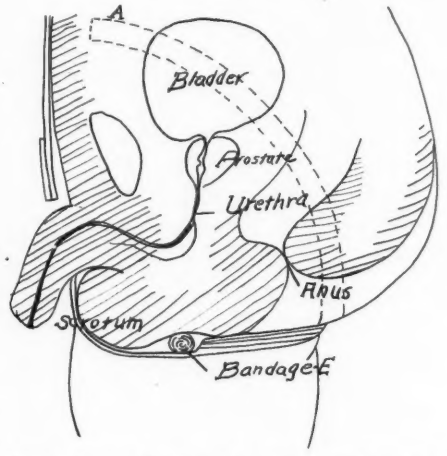

Fig. 6. Lateral view, showing how bandage E prevents the scrotum from slipping posteriorly.

The following table shows briefly the results obtained in the injection treatment

Name and Age	Cc. Fluid	Number Treatments, Sodium Cc. Morrhuate	Number Simple Aspirations	Days of Treatment
A. C. 42	150	1–3	1	14
J. D. 53	360	1–3	1	36
W. M. W. 65	570	1–5	1	12
J. P. 75	660	1–5 1–5	1–180 cc. 1–150 cc. 1–250 cc. 1–30 cc.	47
P. W. 71	330	1–5	1	30
S. R. B. 50	540	1–3 1–2	1–250 cc.	22
D. D. 26	660	1–3 1–3	1–200 cc. 1–100 cc. 1–30 cc.	60

of seven large hydroceles in nonhospitalized patients.

An immediate cure was obtained in all cases. One-half of the patients were located at the end of two years; there was a complete cure without complications in those cases located.

The radical operation for hydrocele is a very satisfactory procedure and if properly performed should be accompanied by few complications. The injection treatment is not recommended as a procedure to replace the radical hydrocele operation. It will give satisfactory results in large or small chronic hydroceles, and is recommended when the operation is contraindicated or refused.

SUMMARY

Hydrocele is a relatively common condition in adults. In infants it is frequently congenital and connects with the peritoneal cavity.

Mild asymptomatic epididymitis is probably the underlying pathology responsible for the majority of hydroceles.

Tapping is frequently curative in the young but seldom the adult.

Excellent results can be secured with the injection treatment of large hydroceles without co-existing pathological conditions, but as is true of all closed methods of operation, hemorrhage and infection may occur.

The use of the modified Bellvue adhesive suspensory will reduce the local reaction and increase the patients comfort.

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THE SUBMUCOUS METHOD IN THE TREATMENT OF ANORECTAL DISEASES

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IN my recent article on submucous hemorrhoidectomy[1] I described briefly a new method of approach in the treatment of hemorrhoids. Since I had not covered in detail the procedure for all types of hemorrhoids, I wish to describe here a simplified technic for the combined external and internal hemorrhoid.

COMBINED HEMORRHOID

The combined hemorrhoid is simply an extension of the internal swelling, this portion being covered by skin instead of mucosa. Under local or general anesthesia, a v-shaped incision is made at the base of the external hemorrhoid. The cut edge is held gently with an Allis clamp and the skin and mucous membrane covering the combined hemorrhoid is undermined with a blunt, curved, flat-blade scissors. (Fig. 1A.) The mucocutaneous flap is then split along its entire extent thus exposing the hemorrhoidal mass. A suture ligature of No. 00 plain catgut on a small round curved needle is then passed around the apex of the hemorrhoid. The phlebitic mass with its perivascular areolar tissue is completely dissected from its bed. (Fig. 1B.) The resulting two mucocutaneous flaps are allowed to cover the denuded surface. If the flaps are too redundant, they may be trimmed to the proper width, remembering it is preferable to leave a little more than too little tissue in order to avoid either stricture or ectropion. These free flaps, covering the underlying raw surface, will agglutinate readily and heal in a very short time acting like an epithelial graft with a broad pedicle in any vascular area.

ULCERATED HEMORRHOIDS

In treating ulcerated hemorrhoids, it is not necessary to separate the entire mucosa covering the hemorrhoid. I find it more expedient to undermine the mucosa up to the margin adhering to the ulcer. The hemorrhoidal mass is then removed together with the adherent portion of the mucosa thus leaving behind two healthy flaps with which to cover the raw surface. The after treatment employed in submucous hemorrhoidectomy has been described in my previous article on this subject.

Having found this technic so completely successful in the treatment of all types of hemorrhoids, I have extended the application of this method to other pathologic conditions present in the anorectal region, such as anorectal stricture, anal fissure, anal fistula and rectal polyps.

ANORECTAL STRICTURE

Anorectal stricture denotes a constriction of the lumen of the anal canal. This condition may be either benign or malignant. I shall consider only the benign strictures. These are usually due to such causes as anorectal fistulae or their improper excision; it may also follow injections of chemicals for the treatment of hemorrhoids and pruritus ani, after operative treatment of hemorrhoids in which too much skin and mucosa have been removed or after hemorrhoidectomy by the cauterization method. This condition causes difficult and painful bowel movements sometimes tinged with blood and pus due to a superimposed infection. Occasionally, hard fecal matter forced through a constricted anal orifice will cause the formation of fissures.

The various treatments advocated for this condition have not proved satisfactory. Forcible dilatation of the stricture is frequently unsuccessful on account of the

constricting band reforming as the healing progresses. Incision with packing of the wound is usually painful and frequently leaves behind an unyielding scar.

The method proposed here is an outgrowth of the submucous operation for hemorrhoids. A perpendicular incision is made through the middle of the stricture. (Fig. 2A.) The wound edge at the incised mucocutaneous angles are grasped with two Allis clamps and stretched outwardly so as to oppose rectal mucosa to anal skin. The rectal mucosa is then undermined with a curved Mayo scissors for a distance of about 1 to 1½ inches, depending on the extent of the stricture. This is done in order to have a mobilized flap of rectal mucosa of sufficient size to cover the underlying raw area. A running subcuticular suture of No. 00 plain catgut is then passed transversely through both edges of mucosa and skin. (Fig. 2 B.) This suture approximates the upper mucosal flap to the lower cutaneous edge without any undue tension or constriction of skin and mucous membrane. (Fig. 2 C.) The loosened mucosa, acting like a skin graft, adheres to the underlying raw surface within a short time, prevents the reforming of the stricture by granulation and scar formation and thus produces a permanent increase in the lumen of the anorectal canal. This procedure is not indicated in the treatment of tubular strictures caused by lymphogranuloma inguinale.

There is little postoperative pain or bleeding. Patients are able to move their bowels on the third day with very little discomfort after the administration of mineral oil or some other mild cathartic.

ANAL FISSURE

Anal fissure in the last analysis is a crack in the mucosa, or mucosa and skin of the anal region. It may be acute or chronic depending on the duration of the disease. This condition is usually brought about by the passage of hard fecal matter causing a split in the mucosa. This may be extended by long continued irritation to the anal cutaneous region. The most common symptom is pain on defecation frequently accompanied by slight bleeding. The fear of painful stools leads to constipation which further aggravates this condition.

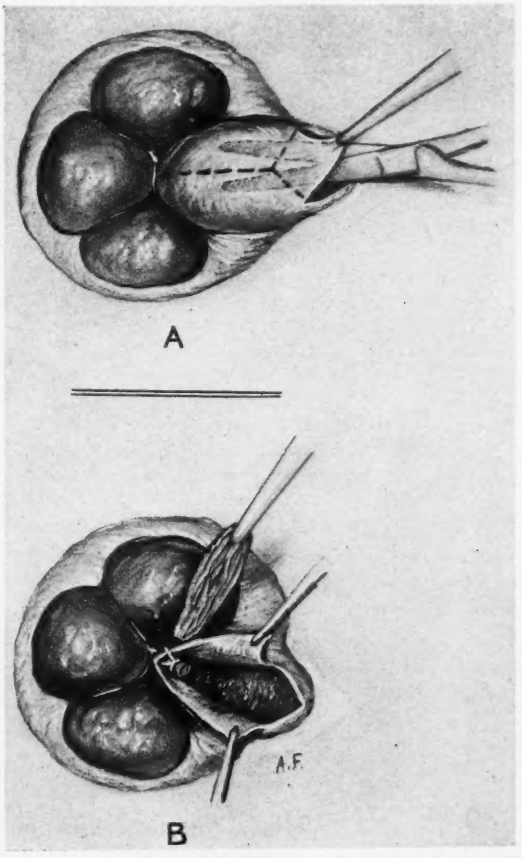

Fig. 1. A, v-shaped incision and undermining of skin and mucous membrane. B, excised hemorrhoid and raw surface to be covered by the two mucocutaneous flaps.

The two methods most commonly used in the treatment of anal fissure are the injection of anesthetic oil solutions and the wide excision methods. The injection of anesthetics are at best palliative, not being a permanent cure nor removing the diseased tissue. In fact, it may aggravate the condition by causing infection and abscess formation.[2] The wide excision method removes an excessive amount of skin, mucosa and underlying tissue leaving a raw surface which can heal only by granulation and scar formation resulting in anorectal stricture. Prolonged postoperative pain and at times infections followed by secondary hemorrhages are other complications which may follow this operation.

These objectionable features are eliminated when the fissure is operated upon by the submucous method. A local anesthetic, preferably 1 per cent novocaine solution is used. No preliminary dilatation of the anal sphincter should be resorted to for such manipulation inflicts trauma to the sphincteric muscle and to the anorectal tissues. A small v-shaped incision is made at the outer margin of the fissure. (Fig. 3A.) The mucosa or the skin and mucosa, if the fissure extends into the skin, is undermined for the entire length of the fissure, wide enough on either side to allow for the longitudinal excision of the diseased strip of skin and mucosa and to leave behind a healthy flap on either side sufficient to cover the underlying raw surface. (Fig. 3B.) These flaps adhere promptly to the denuded area and heal readily without the formation of

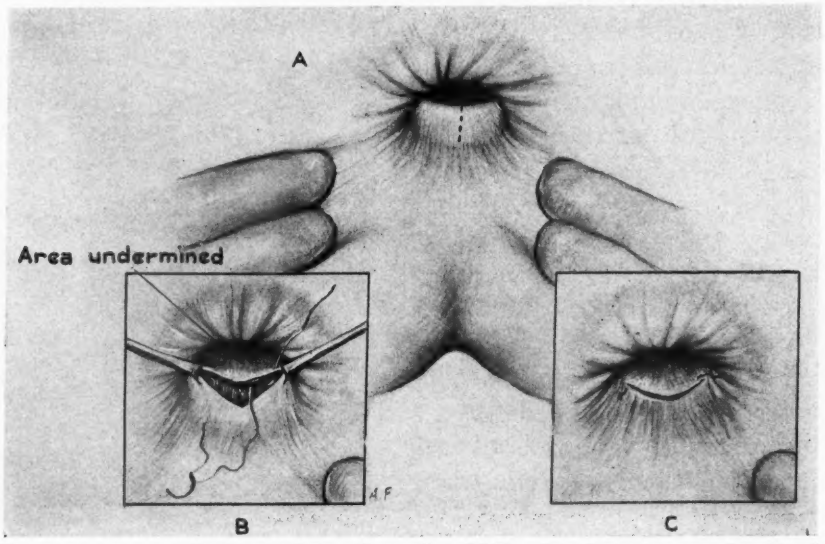

FIG. 2. A, perpendicular incision through middle of stricture. B, undermined mucosal flap being sutured to cutaneous edge. C, appearance of anal region after operation is completed.

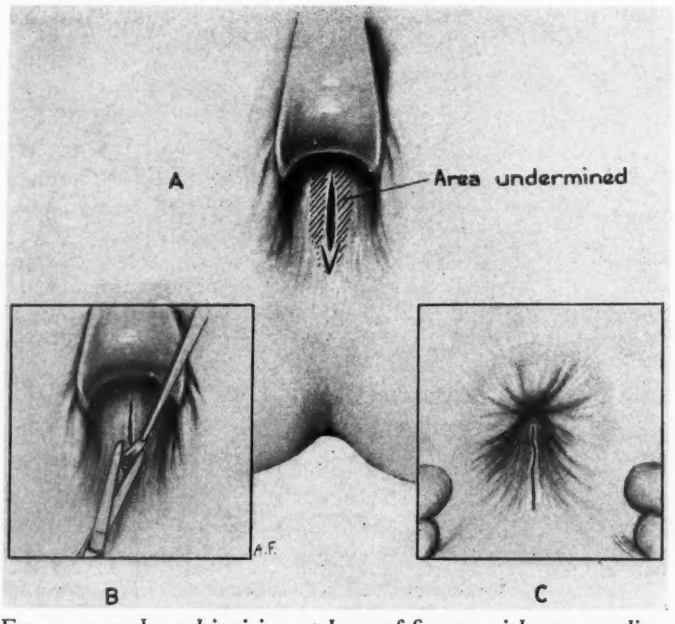

FIG. 3. A, v-shaped incision at base of fissure with surrounding mucosa undermined. B, excision of fissure edges. C, appearance of area at conclusion of operation.

scar tissue. (Fig. 3c.) Any bleeding vessel encountered during the operation is taken care of by a fine absorbable suture ligature.

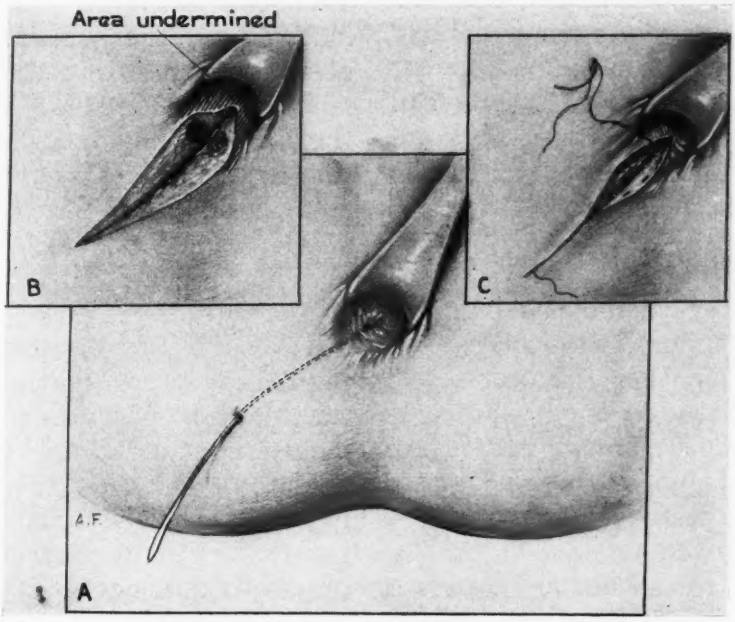

Fig. 4. A, passing of probe through fistulous tract. B, fistulous tract excised and mucosal edges undermined. C, interrupted chromic sutures for deep tissues and subcuticular continuous plain catgut suture completing closure of wound.

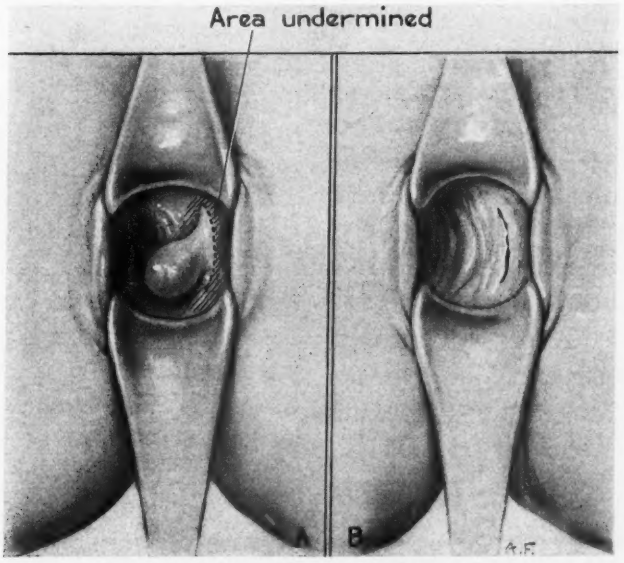

Fig. 5. A, undermining of base of polyp and mucosa surrounding it. B, excision of polyp with its mucosal support by means of elliptical incision.

When the fissure is large enough to be identified as an ulcer of the rectum, the procedure is the same as above with the additional freshening of the ulcerated surface in order to allow for the prompt agglutination of the mucosal flaps.

ANAL FISTULA

Anal fistula is usually the end result of a previous perirectal abscess. Patients almost always complain of a more or less purulent discharge about the anal region. Where there is an intermittent discharge a patient will be aware of the occurrence of a tender swelling accompanied by a sudden painful discharge of blood-tinged pus. This is due

to the temporary closure of both ends of the fistulous tract with the interference of free drainage and accumulation of secretions. Fistulae may be open at one end only and are classified as blind internal and blind external fistulae depending upon whether they open inside or outside the anorectal canal. The most common form is the complete fistula having openings both inside and outside the canal.

The usual treatment of this condition is the laying open of the fistulous tract, curetting it thoroughly and packing with gauze in such a manner as to encourage the formation of granulation and scar tissue from the bottom of the cavity thus preventing the premature closure of the surface epithelium.[3] By this method the healing is very slow and painful on account of the repeated gauze packings and the final picture results in a deformed anal orifice.

We can obtain much better and quicker results by using the following method: Under local or general anesthesia, a probe or a grooved director is passed through the fistulous tract and the bridge of tissue in front of it is completely incised. (Fig. 4 A.) The fistulous tract is then excised thoroughly including the two openings. The mucosa bordering the open wound is undermined for a distance of about ¼ of an inch. (Fig. 4B.) The tissue immediately underneath the skin and mucosa is sutured together by several not too closely and tightly placed No. 00 interrupted chronic sutures. A continuous subcuticular No. 00 plain catgut is run along the skin and mucosa a short distance away from the edge in order to allow for wound drainage. (Fig. 4C.)

Complete healing takes place in eight to ten days. The patient is kept on a liquid diet for the first three days followed by a soft diet after the first bowel movement. Mineral oil administered in ½ ounce doses twice daily will usually suffice to keep the bowels open, otherwise a more active cathartic such as sodium phosphate may be prescribed.

BENIGN POLYP

The benign polyp is another not uncommon disease found in the rectal region. There are two kinds of benign polyps, the mucous and the squamous. The mucous polyp originates directly from the rectal mucosa and is covered by columnar epithelium. The squamous polyp arises from the anal region and is covered by squamous epithelium. Both kinds may be either sessile, resting on a broad base, or they may be pedunculated, resting on a narrow stalk.

The sessile tumors are usually treated by fulguration or excision and cauterization of the bleeding base. This method is very dangerous as the rectal wall may be burned beyond its thickness causing bleeding and ulceration. The pedunculated type is commonly tied at its base and excised. This procedure does not always prevent a recurrence of the growth. The inclusion of mucosal tissue within a ligature causes pain, congestion, edema, strangulation and necrosis.

These benign growths whether sessile or pedunculated are best treated by the submucous method which, in this case, consists in the complete removal of the polyp bearing portion of the mucosa. Under local anesthesia an elliptic incision is made around the base of the growth and a little more than the polyp bearing area of the mucosa is loosened up with a blunt curved flat-blade scissors. (Fig. 5A.) The polyp with its mucosal support is excised and any bleeding vessel encountered is controlled by a suture ligature of No. 00 plain catgut. The loosened mucosa covering the denuded area will soon agglutinate and the edges will unite readily within a few days. (Fig. 5B.)

The submucous method can be applied successfully in removing these benign growths when there are only a few solitary polyps within the reach of the operator. It cannot be used for very evident reasons in the disease known as multiple polyposis, diffuse polyposis or polypoid disease of the intestinal tract.

SUMMARY

A surgical procedure is presented here for the treatment of various anorectal diseases. The main object of the submucous method is the conservation of the skin and mucous membrane lining the anorectal region. This point is being strongly emphasized in order to avoid excessive scar formation during the healing process resulting in the production of the dreaded complication known as anorectal stricture.

Other advantages that this method offers are the elimination of postoperative pain, by omitting the use of the cautery and of sutures through the skin and mucous membranes causing burning, constriction, swelling and necrosis of tissues.

The prevention of primary and secondary hemorrhage and postoperative infection is accomplished by ligating all bleeding points at the time of operation and by the absence of large granulating areas, exposed to the invasion of pathologic organisms which abound in the anorectal tract.

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Any child who continues to vomit during the first day or two of life while being fed a normal amount of breast milk or a reasonable formula should be investigated by roentgenography for intestinal obstruction.

THE USE OF A SULFHYDRYL SOLUTION IN THE TREATMENT OF BURNS*

PRELIMINARY REPORT

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THE rôle of the sulfhydryl (SH—) radical has been shown to be of great importance in tissue growth and the practical application of the knowledge gained in the study of compounds containing this radical, to wound healing, has been suggested and also has been carried out in the past. In a detailed study of respiratory enzymes by the University of Wisconsin biochemists under the direction of C. A. Elvehjem and P. W. Wilson[1] sulfhydryl compounds in this rôle are discussed extensively in relation to glutathione in Chapter VI by E. S. Gordon, M.D. and W. B. Christensen, and summed up as follows: "Thus it appears probable that at least one of the important biological functions of glutathione, as well as the other SH— containing compounds, is related to growth. This view is consistent with the older observation that rapidly growing tissues contain increased amounts of reducing substances, as evidenced by a lowering of the redox potential, and increased amounts of sulfhydryl containing compounds in particular. It also may lend support to the original theory of Rapkine (1931) that mitosis is preceded and accompanied by a chemical rearrangement of nuclear protein in such a way as to free additional SH— groups. In addition, cancerous and embryonic tissues are known to contain larger amounts of glutathione than are present in normal resting tissues. In the absence of any clear-cut demonstration of the function of this compound as a carrier in the respiratory systems of the intact living organism, it is possible that its biological importance may lie in its capacity to maintain the functional activity of various enzymes which act in growth and respiration,—two of the most characteristic and vital properties of living tissue."

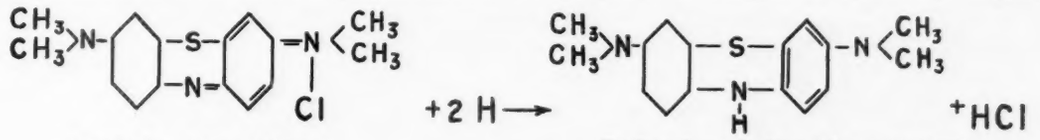
Reimann[2] states that Hammett, working up from plants, through paramecia, rats, mice and finally man has established that the essential chemical difference between the nucleus of a cell in mitosis and the nucleus of a cell in the resting condition, is a rearrangement of the sulfur in the molecules so that this element appears in the chemical group sulfhydryl; i.e., SH—.

Following the use of thiocresol in a solution of 1:10,000 as a wet dressing on a number of stubborn wounds he concludes that thiocresol stimulates mitosis and he states: "That it is the SH— radical of the compound which is the effective agent is clear from rigidly controlled animal work in which plain cresol (*i.e.*, the same chemical base minus the SH— radical) was used and from the results obtained with many compounds containing the SH— group and their homologues containing other groups."

Riley[3] used cysteine hydrochloride (as a 0.5 per cent ointment in lanolin) on skin "reactions" following deep *x*-ray or radium therapy and concludes that undoubtedly healing was hastened. He states further that decubitus ulcers, burns, scalds and traumatic epithelial defects also respond favorably to the ointment. In commenting on the sluggishness of healing of ulcers of burns he postulates that this may be due in part to coagulation of the proteins by heat in place of their normal slow breakdown (with unmasking of sulfhydryl groups) such as might follow trauma.

* From the Golden State Hospital, Los Angeles, California.

These facts have stimulated some clinical investigation of a sulfhydryl solution* in the treatment of burns and since the results in the cases in which it has been tried to this time are uniformly good, this preliminary report is submitted with the hope that more widely distributed investigation of this type of treatment for burns will be stimulated. It must be agreed, generally, that a reliably efficient and adequate treatment for burns has not been evolved as yet; and from the work which has been done previously with sulfhydryl compounds, there is much to commend extensive study of their use in the treatment of this type of wound.



Methylene blue (colored) Reduced methylene blue (colorless)

Fig. 1.

Hydrosulphosol as shown by analysis is a ready and convenient source of sulfhydryl linkages and in addition contains pentathionate (ion) in compounds of polysulfides and thiosulfates in aqueous solution. When diluted with water or in the presence of air, it forms a solution of colloidal sulfur. In the undiluted form it has a hydrogen ion concentration of 10. Chemical analysis of the solution by Dr. A. J. Salle, Assistant Professor in the Department of Bacteriology, University of California at Los Angeles, is as follows:

	Per Cent
Specific gravity	1.032
pH of solution (glass electrode)	10.2
pH after exposure to air until solution becomes colorless	6.5
Solids remaining after evaporation of 100 Gm. of solution to constant weight	10.56
Calcium from calcium oxide	0.549
Total sulfur on acidification	1.366
Total sulfur by iodine titration	1.46
Sulfur as sulfide ion	0.30
Sulfur as thiosulfate ion	0.22
Sulfur from polysulfide	1.256
Stability of solution	
1 cc. hydrosulphosol added to 200 cc. distilled water precipitated colloidal sulfur in fourteen seconds.	
Sulfhydryl ion (methylene blue titration)	0.237

* Hydrosulphosol, supplied by the Earl Hill Wilson Foundation for Medical Research, Los Angeles, California.

In further study of the concentration of sulfhydryl groups in this preparation, Dr. Salle[4] has determined that it is capable of yielding twelve times the concentration of these groups as compared with those present in the solution of sulphurated lime, N.F. This was determined by the use of a solution of methylene blue. This dye is decolorized to the leucocompound by the hydrogen of the sulfhydryl radical according to the above equation (Fig. 1).

He adds further that human blood is said to contain about 0.040 Gm. of glutathione per 100 cc. However, only 11 per cent or 0.0045 Gm. of this compound is present as sulfhydryl groups. On the other hand hydrosulphosol contains about 0.237 Gm. of sulfhydryl ion per 100 cc. of the preparation. This means that hydrosulphosol is approximately fifty times more concentrated in sulfhydryl ion than human blood.

Studies of possible germicidal effects of this preparation and also its influence on the rate of tissue growth in culture are being carried out but are incomplete at the present time. Using spot tests, Dr. T. D. Beckwith,[5] Professor of Bacteriology, University of California at Los Angeles, states that little effect has been noted with staphylococcus. But Dr. Beckwith himself stated he is uncertain as to the validity of the use of the spot technic with a preparation of this structure. Practically, however, in the small series of cases presented, infection has not occurred in the wounds. This includes one case which was not seen until the third day and which had been treated with ointment those three days. Perhaps further investigation will show some connection between antibacterial action and stimulation of natural factors of resistance within the cells by the sulfhydryl groups.

The treatment of burns caused by ultraviolet radiation produced experimentally, suggested by Dr. Ralph R. Mellon, Medi-

cal Director of the Institute of Pathology, The Western Pennsylvania Hospital, Pittsburgh, has been reported by McBroom[6]

Fig. 2. Eschar which formed on burned surface of right leg using hydrosulphosol compresses for twenty-four hours.

and she concluded that the results appeared to justify a thorough-going study under conditions that more nearly approximate those encountered clinically.

The solution, hydrosulphosol, has been applied to burns in various ways: by the use of compresses kept saturated, bath and by spraying. The best method so far seems to be the use of compresses or repeated baths over a period of twelve to twenty-four hours followed by the use of a heat cradle and spraying. It was found in the treatment of second degree burns when this was first undertaken that an eschar formed after the use of compresses or bath, making it possible to carry out subsequent treatment by the dry method. The eschar which forms if the compresses are discontinued in twelve to twenty-four hours is thin and pliable and except in the deeper burns healing occurs beneath it quite rapidly with apparently minimal amount of scarring.

One such eschar which separated from the anterior surface of the thigh in eighteen days, measured $^{57}/_{100}$ mm. in thickness. It could be rolled into a small caliber tube easily but still presented firm resistance to being torn or pulled apart. Preliminary treatment in all cases consists of thorough cleansing of the burned regions and débridement. In the cases in which there has been deeper tissue destruction, the eschar begins to separate in two to three weeks. So far saline compresses have been used on this type of burn when the eschar starts to separate but it is planned to use compresses wet with hydrosulphosol to see whether further stimulation of the reparative process will result, or an ointment containing hydrosulphosol or the sulfhydryl linkages present in hydrosulphosol which is being prepared. So far no skin grafting has been necessary.

Adjuncts to this treatment for burns do not differ from those used in any other method: treatment of shock, control of pain, maintenance of fluid balance, high vitamin diet, etc.

The chief disadvantage thus far in this treatment is the odor of the solution, for like all sulfur containing compounds, this is quite disagreeable. Patients, however, seem to become accustomed to it in a short time and they have made no particular objection to it on that score. Most of the patients, too, have complained of pain when the solution is applied to the burned regions before the formation of an eschar. This is described as burning in character but does not persist over one or two hours. Half strength solutions are planned in the future to see if this can be avoided without interference with the formation of eschars.

CASE REPORTS

Case 1. O. H., a white male, aged twenty-nine, had second degree burns (fire) of the major portion of the left leg below the knee and of the fingers of the left hand. The burns on the fingers were treated with hydrosulphosol com-

presses, those on the left leg with ointment. Thin, pliable eschars formed on the fingers and dressings were discontinued after two days.

asphalt) of face and arms. All burns were treated with hydrosulphosol. Good eschars formed and began to separate on the eighth

Fig. 3. Eschar which formed on chest and abdomen on three-day old burn with the use of hydrosulphosol compresses for twelve hours.

Healing of the fingers was complete on the sixth day. The leg healed completely in two months. No permanent disability resulted.

Case II. H. O., a colored male, aged fifty, had first and second degree burns (fire) of both hands, both thighs and genitals. Hydrosulphosol compresses were used on the hands, tannic acid and 10 per cent silver nitrate on the thighs, and ointment dressings on the genitals. Satisfactory, thin and pliable eschars formed on the hands and no dressings were necessary after two days. Hydrosulphosol was applied at intervals of two to three hours on the burns of the hands by wet sponges for three days more, however. Good tannic acid and silver nitrate eschars formed on the thighs. These burns were deep second degree burns and after the eschars had separated skin grafts from the abdomen were used to cover the defects. Saline compresses were used on the genitals when granulation tissue developed. These burns became infected. The scars on the hands are very satisfactory and cause no permanent disability. He is still under observation.

Case III. W. M., a white male, aged twenty-seven, had second degree burns (hot

day. Gentian violet was applied to a few moist regions. They were all dry and clean but one small region when the patient was last seen, on the twelfth day after his injuries.

Case IV. E. B., a white male, aged thirty-two, had first and second degree burns (hot metal) of the anterior surfaces of both thighs and left foot and heel. All were treated with hydrosulphosol, first by compresses, four days, and then by spraying. Good eschars formed which began to separate on the eleventh day. Healing was complete on the thirty-third day.

Case V. F. G., a colored male, aged thirty-two, suffered second degree burns (fire) of the anterior surface of the right leg extending from the knee to the ankle, and first and second degree burns of both hands on the dorsal surfaces. Hydrosulphosol compresses were applied to the burned regions. Good eschars formed in twenty-four hours. The compresses were discontinued and a light cradle was used. This patient was transferred to another hospital where he was hospitalized for two weeks and at that time the eschar that had separated slightly at the edges was removed and ointment dressings were substituted. The patient was re-

examined here three weeks after he had left the hospital. The burned regions of the hands are well healed and the one on the anterior surface of the right leg is healing satisfactorily.

Case vi. D. S., a Mexican female, aged twenty-seven, sustained second and third degree burns (steam press) on the dorsal surfaces of the index, middle, ring and little fingers of the left hand and the ulnar surface of the thumb. The burns extended over the metacarpophalangeal joints of the middle, index and ring fingers. Débridement was performed and a hydrosulphosol bath instituted for thirty minutes. The wounds were dressed with gauze moistened with hydrosulphosol and the patient was instructed to keep the dressings wet. She returned daily for treatment and each time the fingers were soaked in the hydrosulphosol bath.

Eight days after the injury, the patient was admitted to the hospital to have compresses applied to the fingers. The eschar which had been thin and pliable and had permitted almost full motion in the fingers began to separate, and in the regions where the third degree burns had occurred there was some slough beneath the eschar. This slough separated completely in five days except on the thumb where the burn was limited to second degree. The wounds of the fingers granulated well with an ointment dressing after that time and were completely closed ten days after the patient was discharged from the hospital. The scars were hypertrophic and *x*-ray therapy was used to combat this. The patient returned to work nine weeks after the burns had been sustained and when she was last examined twelve weeks after the injury the scars on the dorsal surface of the fingers were soft and there was no limitation of motion in any of the fingers.

Case vii. R. S., a white male, aged twenty-three, sustained first and second degree burns (hot metal) of face, both arms, hands and both legs, and second and third degree burns of penis. The burned regions were débrided and hydrosulphosol compresses were applied. Good eschars formed in twenty-four hours but hydrosulphosol compresses were continued for the burns on the genitalia for one week. The patient is still under treatment but his course has been entirely satisfactory so far.

Case viii. G. G., a white male, aged sixty-four, had second and third degree burns (hot water) of left arm extending from the shoulder to the wrist completely encircling the arm except at the elbow. The burns had been treated with ointment dressings for twelve hours before hydrosulphosol compresses were substituted. Good eschars formed in twenty-four hours, which were soft and pliable. The compresses were continued another twenty-four hours. Following that the eschars were sprayed every two hours. The eschars began to separate at the edges one week after compresses were first applied and normal saline compresses were applied. This softened the remaining portions of the eschars. Some soft tissue sloughing occurred in the more deeply burned regions. When this slough had separated zinc oxide dressings were used. Subsequently an ointment incorporating some of the sulfhydryl linkages was used. The latter seemed to stimulate healing considerably. The patient returned to work before healing was complete and there have been some abrasions of the thinner portions of the scars necessitating treatment up to the present time. There has been no contracture of the scars to cause any limitation of motion in the arm.

Case ix. B. G., a Mexican male, aged forty-seven, suffered first and second degree burns (steam) of the lower half of the face on the right side, neck and anterior surface of the chest and abdomen. The patient was not seen until the third day after the burns were sustained and they had been treated with an ointment up to that time. The burns had not been débrided. Débridement was carried out under general anesthesia and all of the ointment removed. Hydrosulphosol compresses were then applied and good eschars had formed over the burned regions in twelve hours except in the folds of the neck on the right side. The compresses were discontinued and a light cradle was placed over the patient and the burned regions were sprayed with hydrosulphosol for the next two days. All the eschars were soft and pliable and the patient did not complain of any discomfort. They began to separate on the eighth day after the burns had been sustained. Healing had occurred under the eschars and the last portions separated on the sixteenth day. There has been no contracture of the scars and the patient was able to return to work on the eighteenth day after the injury.

CONCLUSIONS

While no extensive conclusions are intended at this time, it is believed that hydrosulphosol, a solution supplying avail-

able sulfhydryl compounds, shows definite promise of being an efficient preparation and one probably superior to those in present use in the treatment of burns and that it warrants further investigation.

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It is . . . important to examine roentgenologically (barium enema) all individuals with a coeliac syndrome to detect any unrotated cecum or mobile cecum, because surgical correction of such abnormalities may completely relieve the patient's symptoms.

EMBOLIC VASCULAR ACCIDENTS OF THE EXTREMITIES*

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TODAY there are numerous articles written on diagnosis and treatment of emergency conditions in surgery, but few of these articles deal with a fairly common emergency catastrophy, that of embolic arterial occlusion of the extremities. The reason for this is probably due to the fact that in most of these cases the underlying etiology of the embolus is of such great character that surgical intervention might be questionable or inadvisable. As embolectomy adds very little to the risk of these patients, and as there are few if any contraindications to the procedure, and as one man reports as high as 50 per cent cures when this procedure is carried out, this paper was written in the hope of bringing the attention of these cases to the proper persons early and the patients given the benefit that surgery has to offer them.

Etiology. The etiology of emboli falls into one of the following causes: Heart disease: (1) auricular fibrillation; (2) coronary infarction with mural thrombosis; (3) cardiac failure with dilitation of chambers; (4) valvular disease: (a) bacterial endocarditis, (b) ruptured valve; (5) arterial: (a) atheromatosis and bacterial, (b) trauma.

Of the above causes auricular fibrillation is the most frequent, and as auricular fibrillation is a chronic condition that is quite well taken care of with medication for years, it is probably here that surgery has the most value.

Prophylactic. Prevention of formation of emboli should be kept in mind. The argument for the use of quinidine or other drugs to restore fibrillation to a normal rhythm is well grounded from this angle. Some cardiologists maintain that the continued use of digitalis is indicated in fibrillation as there is very little danger of emboli forming while under digitalis therapy, but that this danger increases as soon as the patient discontinues the use of the drug. There are reports that fibrillation caused by hyperthyroidism never results in embolus formation. This is not true, as just recently we had one such case of a cerebral embolism resulting in death, and there are a few similar cases reported in the literature.

Pathology. From its site of origin the embolus travels along the large arteries until it reaches a portion that is too small to allow it to pass farther. This usually occurs at the bifurcation of the vascular tree. The most common sites of bifurcation where emboli lodge are the following in the order of their occurence (not including cerebral arteries):

1. A profundus which occurs on the lateral side of the femoral artery about 3½ cm. below the inguinal ligament.

2. A. popolitius. Bifurcations to form the A. tibilias and the A. peroneal which occurs at the lower portion of the popliteal space at the lower border of the M. popoliteus.

3. A iliacis externus at the bifurcation to form the A. epigastric and the A. deep iliac circumflex, which occurs under the inguinal ligament; these two factors, i.e., the biforcation and the pressure of the ligament cause a narrowing of the artery at this point favoring lodgment of foreign bodies.

4. A. axillary: The most narrow point of this artery occurs where the A. subscapularis is given off at the lower border of the muscularis subscapularis.

5. A. Brachialis: Bifurcation to form the A. ulnaris and A. radialis which occurs about 1 cm. below the bend of the elbow lying under the M. ulnar tares.

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After the embolus has been arrested in the artery, there occurs a localized spasm of the vessel which further accentuates the circulatory blockage. In due time as a result of stasis a propagating thrombus is formed below the embolus with inflammatory changes occurring in the intima of the vessel. The propagating thrombus may shut off the anastomotic vessels below, thereby increasing the original pathological condition. With the loss of blood to the member there occurs ischemia and death, this occurring first in the nerves then the muscles, fascia and finally the bone. A limb will stand one to two hours with no circulation fairly well, but as time goes on more and more cellular damage is done so that some men believe that after six hours embolectomy is contraindicated. However, others have reported favorable results even up to as late as twenty-four hours. This possibly is due to the removal of the propagating thrombus opening up channels for colateral circulation.

SYMPTOMS AND DIAGNOSIS

Pain is the most common symptom occurring in 60 to 70 per cent of the cases and is of a sudden, sharp, agonizing type with a localization over the site of the embolus. This pain is so severe and different from anything that the patient has had that if one is conscious of this possibility occurring the diagnosis can be made from it alone. After the initial pain, which is probably due to localized spasm of the artery, there is a dull aching and boring type of pain that spreads proliferally over the limb. The patient in due time complains of coldness, numbness and weakness of the extremity. This is due to ischemia. On physical examination one notes a dusky palor present distal to the site of the embolus which later takes on a mottled appearance. The arterial pulse is absent distally and there is an increasing loss of sensation and strength in the limb. There is a definite difference in the temperature of the two extremities, with a falling temperature in the one having the impaired circulation. Arteriography has some advocates as an aid in the diagnosis of this condition. Due to the stasis of blood between the site of blockage and the next proximal bifurcation it is questionable whether puncture of the artery at this point and the installation of radio-opaque material add much in the way of localization. Arterial puncture is not an easy procedure resulting in some trauma plus the possibility of trauma from radio-opaque material. And with the delay of the procedure plus *x*-rays there is much in disfavor and little in favor of this procedure. It was tried in one case (reported below) with no aid whatsoever as to localization or diagnosis.

TREATMENT

There is some controversy at the present time between those advocating surgical intervention and those in favor of medical treatment.

Rykert and Graham, both internists, reported thirty-six cases, and find that they have had equally as good a result from medical management as from surgery. They emphasize physical therapy, heat, massage, postural exercises and the use of a Pavak boot. Keys reporting on 134 cases states that 46 per cent good results have been obtained. Pearse reported 282 cases with good results, but that 52 per cent died within one month from the initiating disease. Nystrom reporting on 383 cases gives 22.5 per cent good late results following embolectomy. DeTakats emphasizes surgical intervention if at all possible, even advocating amputation in cases over twenty-four hours old rather than to subject an already sick patient to the toxic effect of gangrene or a probable useless ischemic limb.

In summarizing the results it appears that about 50 per cent get good results immediately following surgery, but that after a month or more, about one half of these patients die from the intercurrent disease, leaving about 25 per cent good late results. This figure surpasses that of the result obtained by surgery in disease such as cancer of the stomach or bowel.

OPERATIVE PROCEDURE

Due to the fact that most of the points of arrest of the emboli are fairly superficial and that the patient's condition is usually poor, local anesthesia is to be preferred. An incision is made parallel with the artery over the spot of maximum initial pain if such has occurred, otherwise over the point of bifurcation of the artery corresponding to the proximal area of demonstrable impaired circulation. The artery is isolated and freed from the surrounding tissue. A penrose tape is placed under the proximal portion of the artery to act as a tourniquet if necessary. The vessel is then carefully palpated for frequently the foreign body can be felt as a hard nodule. Pulsation of the artery is some aid though not a definite indication as to the exact location of the embolus as the impulse of the heart beat is felt for some little distance below the actual site of the occlusion. If there is some doubt as to whether one is above or below the occlusion, aspiration with a No. 26 gauge needle will clear up the doubt. The vessel is incised longitudinally with the edges held open by silk traction sutures. If the foreign body is not at the site of the incision extention up or down may be done, or gentle probing with a small rubber catheter or a ureteral catheter may be tried. Search should be made for a propagating clot below. A rubber catheter should be inserted distally and a 2 per cent sodium citrate solution injected into the artery. If resistance is encountered, aspiration should be tried or it may be necessary to open the artery more distally. The tissues and instruments should be washed freely with 2 per cent citrate solution. After blood is freely obtained, both distal and proximal portions of the artery the vessel are closed with fine silk or triple 000 catgut, care being exercised to avoid entering the intima of the vessel.

It is agreed by all the observers of this condition that surgical intervention is not indicated in embolic vascular accident of the upper extremities. The collateral blood supply is sufficient to take care of them and medical treatment will suffice.

POSTOPERATIVE CARE

The limb should be wrapped in a copious amount of sheet wadding or cotton and kept at a lower level than the body. No external heat should be applied. Heat accentuates the chemical breakdown of the tissues to produce acids which are detrimental to the cells. Passive exercises should be instituted at regular intervals. The leg should be allowed to hang over the edge of the bed for three minutes and then on the bed for an equal length of time, this repeated five times out of every hour for the first twenty-four hours. Gentle massage stroking the blood distally is of aid. If a Pavak boot is available this should be used more or less continuously until the circulation is adequate. Care should be exercised to avoid prolonged pressure on the heel, as pressure sores are prone to develop in these cases. These cases deserve the aid of surgical care plus all the care that medical management has to offer which should improve the result. Antispasmodic drugs may be used pre- and postoperatively. De Takats reports encouraging results from the use of papavenine hydrochloride in gr. $\frac{1}{6}$ to 1 gr. for both symptomatic and clinical results. Dr. W. Gordon Murray, of Toronto, has shown by experimental and clinical results that the use of heparin for about seventy-two hours has possibilities of being a great aid in the treatment of this condition. As yet it is too expensive for general usage and too new to be recommended dogmatically. It deserves trial and consideration, however.

CASE REPORTS

Case 1. Mr. J. F., age fifty-nine, a sheriff, was admitted to the hospital on February 5, 1939 with a complaint of severe pain in the right side of sudden onset, occurring that afternoon and followed by shock-like symptoms, vomiting with pain mainly in the right flank and radiating down to the bladder. There were no urinary complaints. Physical

findings were essentially normal except for auricular fibrillation. (This condition had been treated previously at the Clinic. The patient had been on digitalis for some time, but had stopped taking the medicine of his own accord about two months previously.) There was a moderate amount of tenderness in the right side of the flank. The blood pressure was 120/80, pulse 90. Laboratory findings were essentially negative on admission. Coliky pains and soreness continued and in twenty-four hours there were microscopic red cells in the urine. Diagnosis of ureteral stone was made, but K. U. B. and intravenous pyelograms were negative. On February 14, 1940 the patient had a sudden, severe agonizing pain in the right leg, at first localized over the upper portion of Hunter's canal, later spreading down over the remainder of the leg, accompanied by numbness, anesthesia, weaknes and paralysis of the foot. The leg became cool and a mottled grey color. A diagnosis of multiple emboli was made, the first having gone to the kidneys and the last to the right leg. Within three hours from onset, embolectomy was performed with the removal of an embolus the size of a pea at the bifurcation of the femoral to form the profundus artery. There was an eight inch propagating clot below. Postoperative course was uneventful, except for the development of a decubitus over the heel, and aggravating paresthesia and muscular cramps in the legs. These were very slow in subsiding and it was six months before the decubitus was healed and the patient was able to walk normally on his leg. Today this patient is carrying on a gainful occupation as sheriff in his home county.

Case II. Mr. H. F., age sixty-nine, a bookkeeper, was admitted to the hospital with a diagnosis of carcinoma of the ascending colon. An entercolostomy was done and the immediate postoperative condition good. On the third day the temperature was 103°F., and evidence of localized peritonitis was present. The patient's heart began to fibrillate rapidly. Under digitalis therapy the heart condition became better and the temperature subsided. About seventy-two hours after the onset of fibrillation and during the night the patient complained of quite severe pain in his left leg. He was given morphine and not until the next morning was the accurate diagnosis made, i.e., embolus with occlusion of the peroneal branch of the tibial artery of the left leg. Due to the patient's rather bad condition being about eight hours old and with the circulatory disturbance mainly localized in the dorsum of the foot and toes, the patient was treated expectantly with heat, massage and postural exercises. The upper portion of the foot became gangrenous, and though the patient's heart condition became fairly normal, with bowel function also becoming normal, sepsis and advancing gangrene slowly sapped the patient's vitality, and death occurred about six weeks after the vascular accident.

The first case is an example of what can be done for these unfortunate patients with a very gratifying outcome, in the author's opinion. If the latter patient had had an embolectomy or amputation, he would have been given considerably more time to live.

SUMMARY

An appeal is made to the medical profession to be on the lookout for embolic accidents, to get them early and to give the patient the benefit of surgical and medical treatment. A résumé of surgical technic of an embolectomy is given and two cases are reported.

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OSTEOPETROSIS*

FOUR CASES IN ONE FAMILY

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OSTEOPETROSIS is fundamentally a disturbance of normal bone formation characterized by increased density of the cortical and spongy portions of the entire skeletal system.

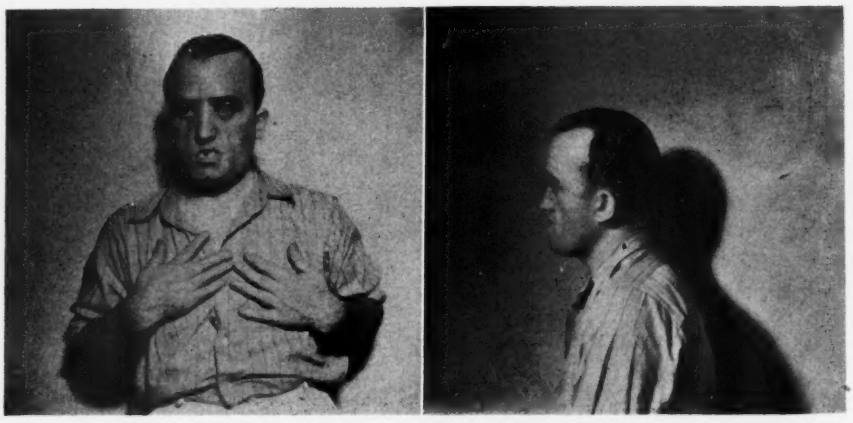

FIG. 1. Case 1. Marked prognathism, prominent forehead and heavy hands. The syndactylism of the left second and third fingers has been corrected.

This disease was first described in 1904 by Albers-Schönberg. Since then only 131 cases have been reported in the literature under varying synonyms—osteopetrosis, marble bones, Albers-Schönberg's disease, osteosclerosis fragilis generalisata, congenital osteosclerosis, marmorknochenkrankheit, os marmoreens and marbo marmoreo.

All phases of the condition have been fully and adequately presented by several other authors so that we wish only to summarize the main features of the disease and record the four cases in one family that came under our observation.

The changes in the skeletal system form the evidence for the establishment of the diagnosis, but it is only the secondary changes which cause the symptoms affording or suggesting its clinical recognition.

The pathological basis for the disease is based on the compiled evidence of almost twenty autopsies and bone biopsies. There is increased density of all bone. In the spongiosa the increase results from augmentation of the number and thickness of the individual trabeculae, while in the cortex there is an increase and packing of the lamellae. The spongiosa may reach such a degree of density that it is indistinguishable grossly from the cortex. The thickening of the bone is by endosteal and enchondral formation. The marrow cavities are encroached upon, but the hematopoietic tissues remaining are active.

Histologically, the architectural pattern of the bone is disorderly and irregular. Osteoblasts may appear either normal or abnormal but are often increased in number. There are no definite changes in the osteoclasts. The bands of varying densities reported in certain cases are not a fundamental picture of the disease but represent the evidence of a concomitant nutritional disease of the bone during its growth period. There is no evidence to demonstrate a change in the relative chemical composition of the bone.

There are no characteristic clinical features, for those symptoms which may

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suggest the diagnosis are due to secondary pathological changes. The roentgenographic diagnosis is made on the marked lower jaw is interesting to note, and was a constant factor in the four cases we present.

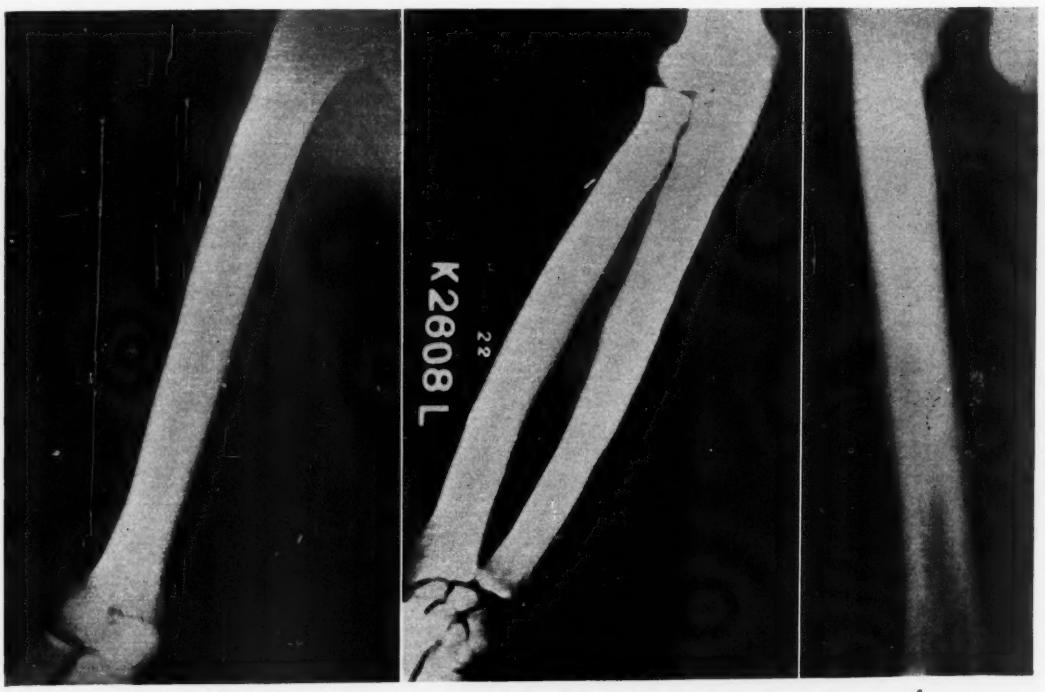
Pathological fractures are frequently

a *b* *c*

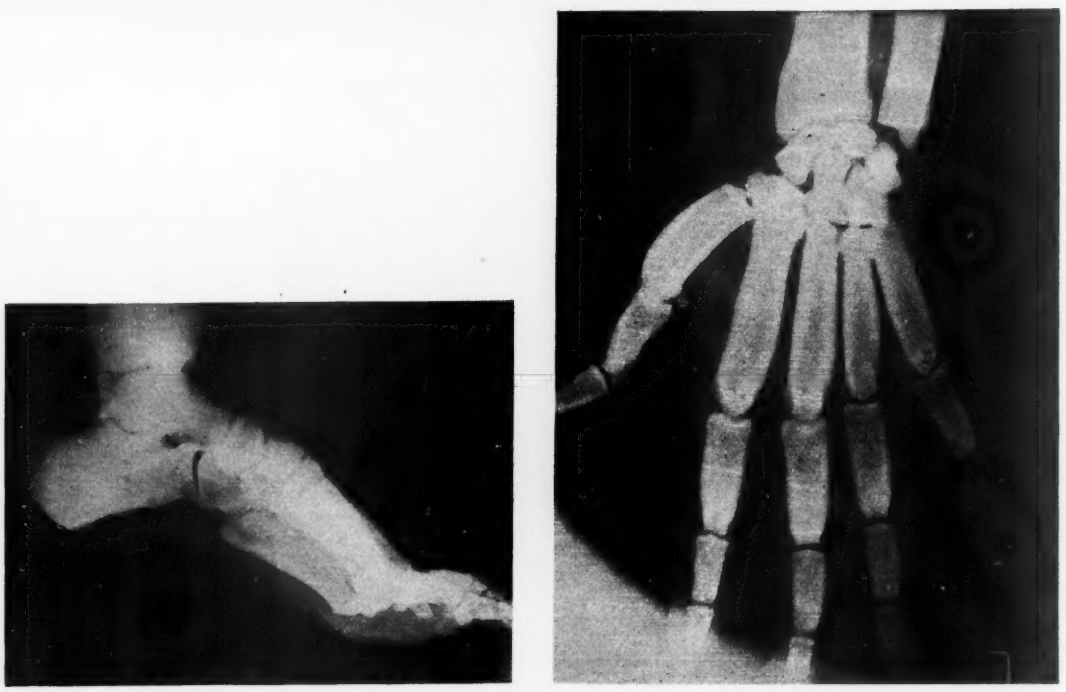
Fig. 2. For descriptive legend see page 446.

increase in density of the shadow of the skeleton with complete or partial loss of the normal osseous structure. There is diminution of the marrow cavities. Club-like thickenings of the posterior clinoid processes and narrowing of the sella turcica are common findings. There often may be transverse bands of greater and lesser density parallel to the position of the epiphyseal line in the shafts of the long bones. The overgrowth in the size of the noted but they are not an essential feature. The marbleized bone is not necessarily more brittle, and, if fractures occur, there is no delay in their healing.

There frequently is an associated anemia. Certain authors have believed that this is a distinct feature of the disease and that there is inhibited hematopoiesis. It would seem more likely that this is entirely a secondary phenomena and in reality a myelophthisic type of anemia due to



d *e* *f*



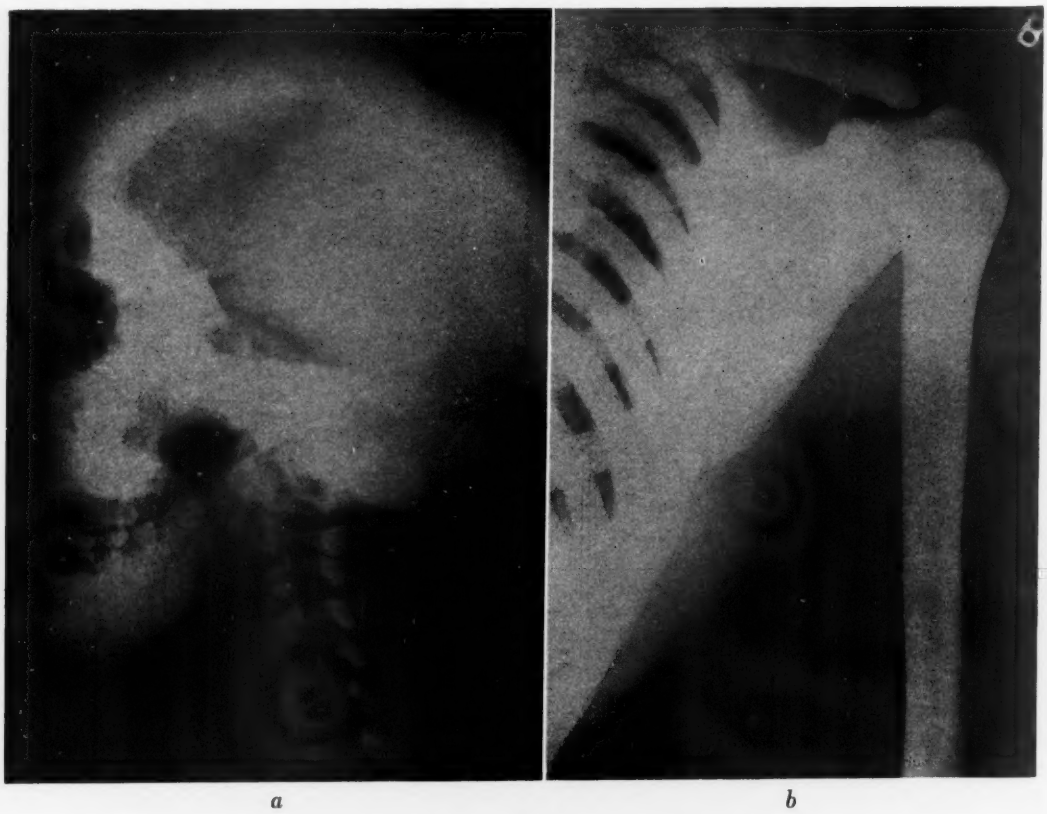
g *b*

FIG. 2. Case 1. There is a diffuse homogenious bony sclerosis involving the entire skeleton. Roentgenographs are unusually dense and the bones present a chalk-like appearance. The skull (*a*) shows extensive involvement, the hands (*b*) and feet (*g*) the least. The ribs (*b*) and pelvis (*c*) are characteristic and the long bones (*d*, *e*, *f*) show moderate thickening with encroachment on the medullary canal.

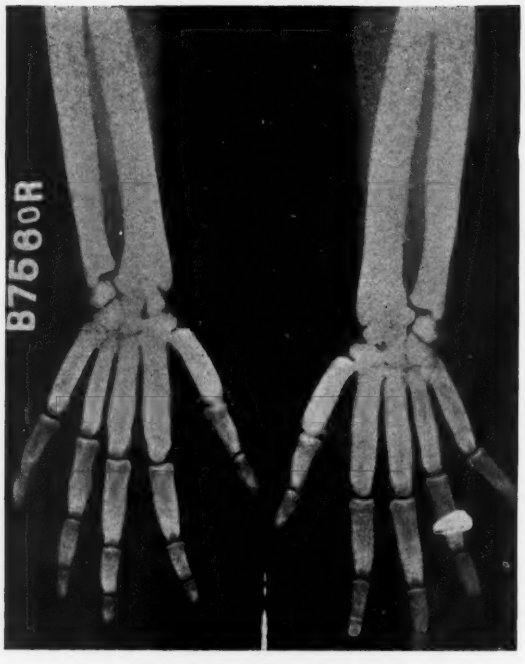
Fig. 3. Case 11. Presents a similar marked prognathism and prominent forehead. Note the syndactylism of the right third and fourth fingers and the large hands.

TABLE I

Date	Author	Case	Sex	Age	Remarks
1935	Comby[4]	1 2	M M	34 yrs. 18 mos.	Brothers. Parents were second cousins.
1937	Falconer and Ryrie[6]	1 2	M F	35 yrs.	Parents were first cousins. Sister.
1937	Gerstel[8]	1	M	3½ yrs.	
1937	Horsch[10]	1	F	16 yrs.	
1938	Anderson[2]	1	F	26 yrs.	Disease discovered when two months pregnant.
1938	Lamb and Jackson[13]	1	F	1 day	Great grandfathers were brothers.
1938	Clifton, Frank and Freeman[3]	1	M	5 yrs.	Parental consanguinity.
1939	Gauvain and Langston[7]	1	F	10 yrs.	
1939	Von Godin[17]	1	M	16 yrs.	
1939	Kramer and Halpert[12]	1	M	3½ mos.	
1939	Kantorek[11]	1	M	4½ yrs.	
1939	Albrecht and Geiser[1]	1 2	M F	7½ yrs. 15 mos.	Cousins. Parents were blood relations.
1939	Creveld[5]	1	F	7 yrs.	
1939	Olin[16]	1	F	72 yrs.	
1939	Heybrock[9]	1	M	1 day	No consanguinity.
1939	Willi[18]	1	M	64 yrs.	



a *b*



c

FIG. 4. Case 11. Selected roentgenographs *a*, *b*, and *c* are typical of the disease.

mechanical interference with the hematopoietic centers in the bone. The marrow tissue that remains is active and normal, although diminished in amount. The anemia itself has no distinctive characters. Its degree is not necessarily proportional to the roentgenographic interpretation of the bone density, but in the autopsied cases the anemia was proportional to the degree of interference with the marrow space. Often the spleen, liver and lymph-nodes will act as accessory hematopoietic centers and hypertrophy.

Fig. 5. Case III. Moderate degree of prognathism and frontal prominence. The eyes are starey. Note the syndactylism of the left index and middle finger and the spade hands.

In children there frequently is an associated hydrocephalus. This is not well explained by impingement on the foramen magnum. However, there is obstruction to the venous flow from the head through the foramina which are diminished in size, and this may be the etiological explanation. Optic atrophy and blindness may be brought about in two ways. It may be secondary to papilloedema from the causes that produced the hydrocephalus; or it may be caused by the mechanical impingement on the optic nerves by the decreasing size of the optic foramina producing a primary optic atrophy. Deafness may be caused by the same mechanism.

Infections of the bone offer the most serious hazard to these patients. In particular, infections of the jaw are to be dreaded, as they are most dangerous to the life of the patient. With the changes in the jaw bones there is malocclusion and spreading of the teeth as well as the basic decrease in the blood supply of the bone. These factors favor the development of dental infections which spread into the mandible and maxilla. The resulting osteomyelitis is most resistant and frequently kills the patient.

The association with syndactylism and achondrodysplasia may be an indication of its hereditary character. The familial and hereditary implications of reported series of cases is so striking that it has been suggested that this defect in bone formation may be a Mendelian recessive character. Consanguinity of the parents has been reported frequently enough to be of considerable significance.

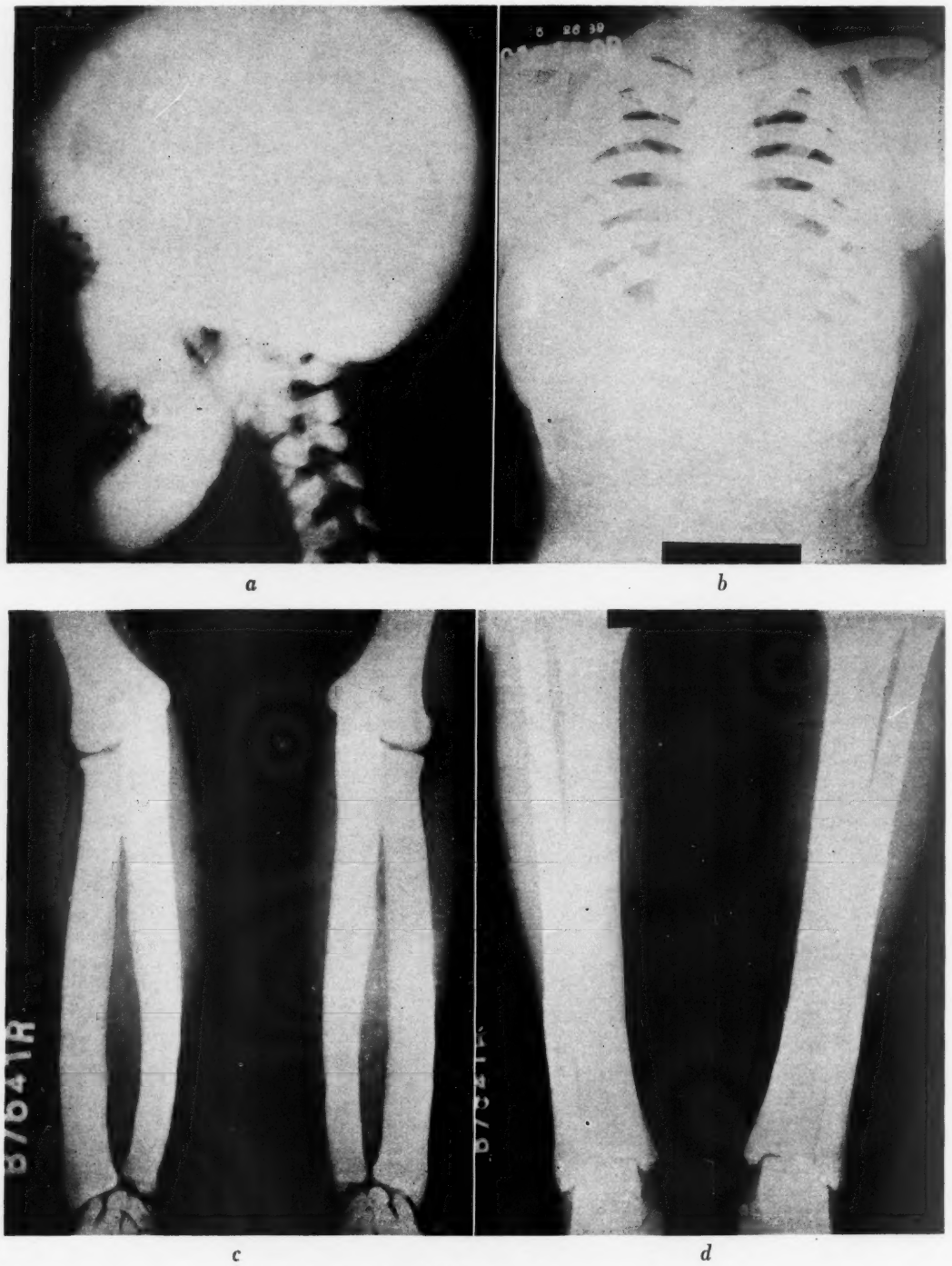
There are no evidences of age, sex, or race distribution. All studies of blood chemistry have failed to reveal any characteristic changes.

No definite etiology has been demonstrated for osteopetrosis. There is no proven endocrine basis for the disorder. Avitaminosis has been suggested but lacks real evidence. While it is currently believed that it is a defect in the genetic arrangement with a faulty differentiation of the bone from mesenchyme, this does not explain the modus operandi of the disorder. It is only possible to say that it is an anomaly of osteogenesis.

While the diagnosis is made from the roentgenographs, the presence of the secondary manifestations should suggest its clinical recognition.

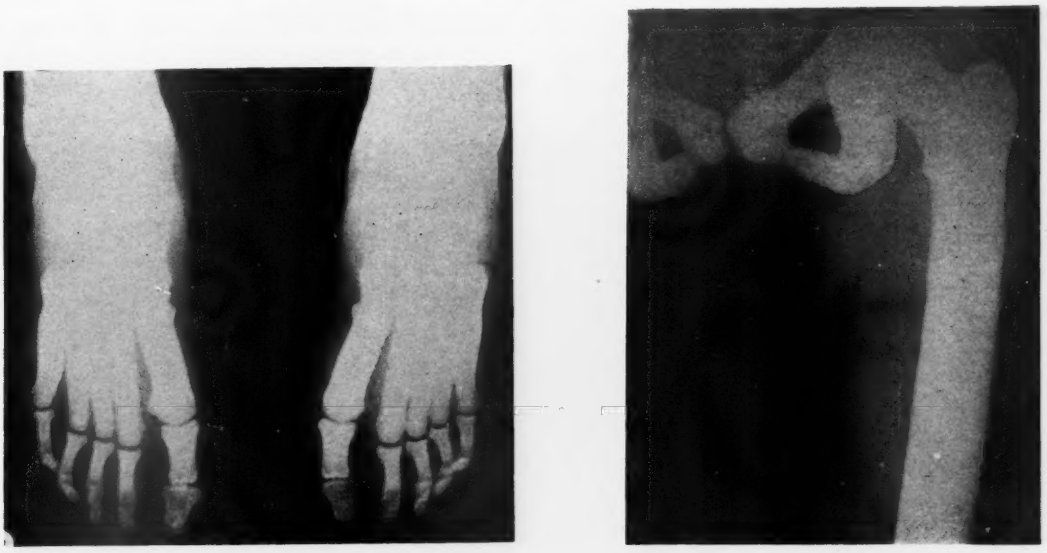
In the differential diagnosis those other conditions which cause increased bone density are to be considered. The systemic causes of bone sclerosis such as syphilis,

tuberculosis and leukemia should readily be detected. Condensing osteitis of Secard is confined to the lumbar vertebra and is accompanied by pain. In osteopetrosis there is no pain. Melorheostosis of Leri is to be distinguished by the distortion of the contour of the bones, by its waxy appearance with candle-dripping inner surfaces, and by its tendency to cross joint spaces. Lead poisoning should be recognized by its systemic manifestations as well as by the localized bone changes. Chronic fluorine intoxication may present a very similar picture but is an occupational disease not uncommon in the Argentine, North Africa, etc.; so that there is a definite history of exposure to fluorides. Paget's disease should offer no difficulty in differential diagnosis.

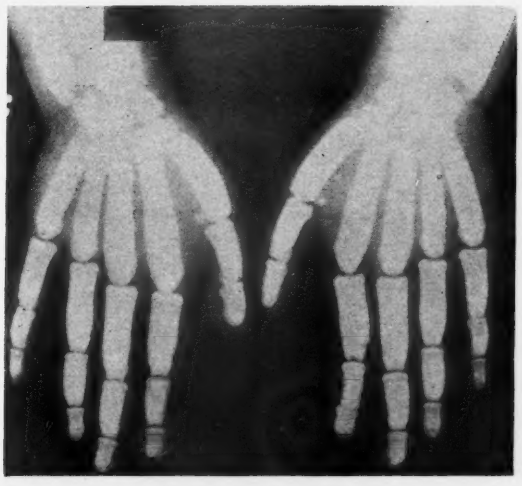


a *b* *c* *d*

FIG. 6. For descriptive legend see page 451.



e *f*



g

FIG. 6. Case III. Roentgenographs reveal a degree of involvement similar to Case I. The medullary portion of the bones is largely obliterated even in the hands (*g*) and feet (*e*).

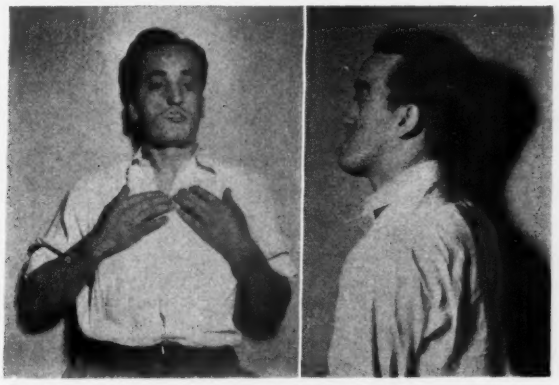


FIG. 7. Case IV. Moderate prognathism, syndactylism of the left third and fourth fingers; large hands.

The skeletal changes of Hodgkin's disease may closely resemble osteopetrosis. However, in Hodgkin's disease the vertebrae may show more involvement than other bones, the skull is rarely affected and the process is not as diffusely uniform. Biopsy of a lymph-node with other physical findings confirm the diagnosis of Hodgkin's disease.

There is no available therapy for this disease, but the prognosis is not necessarily poor. Most of these patients die of intercurrent diseases or bone infections. However, the fact that cases have been reported living to the age of seventy indicates that osteopetrosis is not incompatible with long life.

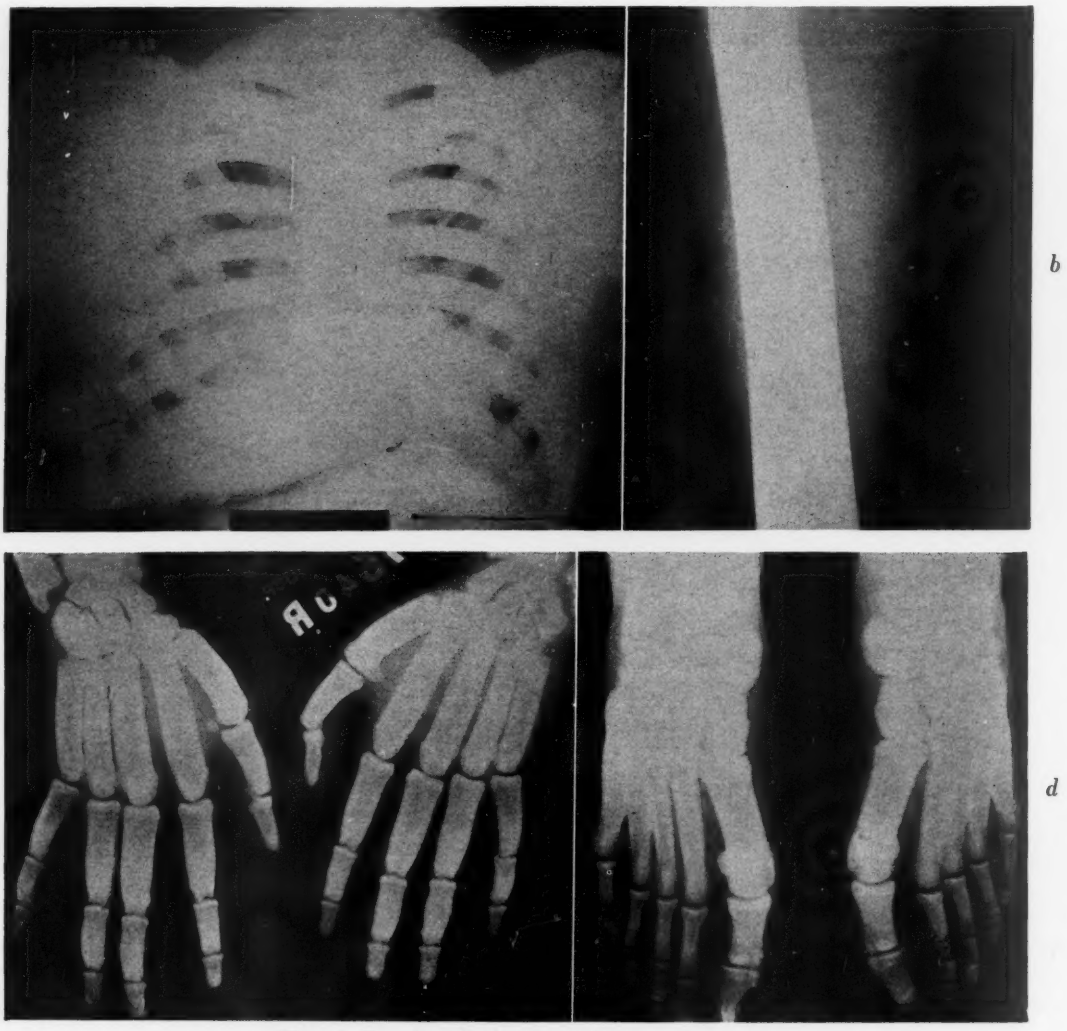


FIG. 8. For descriptive legend see page 453.

CASE REPORTS

CASE 1. Ralph, a twenty-eight year old white male, hospital porter, sought our attention because of his oversized lower jaw. As far as is known, he had had a normal gestation and delivery. Shortly after birth it was noted that he had syndactylism of the second and third digits on the left hand and of the fourth and fifth digits of both feet. The patient further stated that from the time he had been six months old it was noted that his jaw and head were not natural.

The syndactylism of the left hand was corrected by surgical intervention during his childhood with an excellent functional result. A herniorrhaphy at the age of ten was the only other incident in his history.

The patient had known since his youth that his lower jaw was unusually prominent, but it caused no pain and functioned properly. As he grew older the jaw grew progressively larger and protuberant, until it became an acute cosmetic difficulty. With the protrusion of the

lower jaw the teeth no longer approximated those of the upper jaw and all mastication was done with the molars. The front teeth became irregular and uneven and several were removed for cosmetic reasons. The enlarged and poorly functioning lower jaw interfered with phonation and his speech became rather indistinct. However, it was for cosmetic reasons that he sought medical attention.

e *f*

Fig. 8. Case iv. Roentgenographs reveal similar involvement though to a lesser degree than in the brother and two sisters.

Physical examination revealed a fairly well developed and nourished white male adult. There was marked enlargement of the lower jaw with extensive prognathism. (Fig. 1.) This seriously impaired patient's ability to speak rapidly or clearly. The teeth of both jaws were irregular and there was a total of twenty-six teeth; fourteen teeth were in the upper jaw and twelve in the lower jaw. The lower jaw when closed extended 1½ cm. beyond the upper jaw and there was no approximation of the anterior teeth. There was partial approximation of the masticating and grinding teeth. There was no dental sepsis and the gums were in fair condition.

The skin was of normal texture with normal male hair distribution. The head was rather large with a prominent forehead and eyebrows. Eyes were normal save for a mild myopia. The chest was symmetrical although the anteroposterior diameter was somewhat increased. The lungs were normal to percussion and auscultation. The heart showed regular sinus rhythm with a rate of 68. The sounds were of good quality and there were no murmurs. The heart was not enlarged. Blood pressure was 136/80. Both radial pulses were equal and normal. The abdomen showed no abnormalities except for the herniorrhaphy scar. Liver, spleen and kidneys were not palpable. Genitalia were normal. The hands, as well as the fingers, were rather short and stubby and resembled a "spade hand." (Fig. 1.) There were operative scars on the left index finger and middle fingers at the site of the former syndactylism. There was good function of all of the digits, although movements were somewhat slow. The nails were short and irregular and in some cases were not straight on the long sides of the finger. The toes showed webbing of the fourth and fifth digits of both feet. Neurological examination failed to reveal any abnormalities.

Blood: hemoglobin, 95 per cent; red blood count, 4,750,000; white blood count, 6,800; differential, polymorphonuclears, 72 per cent; lymphocytes, 23 per cent; monocytes, 5 per

cent; calcium, 10.5 mg.; phosphorus, 4.72 mg.; phosphatase, 7.7 units. Urine: Specific gravity, 1026; color, dark amber; reaction, acid. Albumin, negative; sugar, negative; Bence-Jones, negative; bile, negative; microscopic, negative.

X-ray report was as follows: Films of the bony skull, thoracic cage and both upper and lower extremities reveal a generalized homogenous bony sclerosis. The medullary portions of the bones are largely obliterated by this process. Most of the bones are likewise increased in width and this is especially noted in the bones of the skull. (Fig. 2*a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*.)

The father was living and well and had had no serious illnesses. There was no knowledge of familial disease or deformity and no gross evidence of the disease. Consanguinity with the wife was denied. The mother died following tenth childbirth, cause said to be "kidney disease." There was no knowledge of familial disease or deformity and the mother was said to be normal. The mother had ten children; one was a miscarriage, another child, perfectly formed, died during infancy, probably due to pneumonia.

The father has had three children by his second wife, all of whom are normal.

Case II. Agnes, happily married, age thirty-three years, has no children. There is partial absence of the nail of her right index finger, syndactylism of the right third and fourth fingers, partial absence of nail of left thumb and index finger and marked prognathism. (Fig. 3.) Skeletal *x*-rays are typical of the disease. (Fig. 4*a*, *b*, *c*.)

Case III. Millie, single, age twenty-four years, reported that her hearing has been failing. Eyesight is progressively failing with concentric constriction of both visual fields. This makes her mental responses slow. She works as a housemaid, etc. She presents prominent eyes, large tongue, webbing of left index and middle finger, webbing of index and middle toes of both feet, almost complete absence of nail of left thumb and index finger and marked prognathism. (Fig. 5.) Skeletal *x*-rays are typical of the disease. (Fig. 6*a*, *b*, *c*, *d*, *e*, *f*, *g*.)

Case IV. Anthony, single, age twenty-one years, is very strong and quite clever. He is a truck driver, but can do auto mechanics, carpentry, plumbing, etc. He is headstrong and presents a splendid physique. He has webbing of left middle and ring fingers, and of right index and middle toes and moderate prognathism. (Fig. 7.) Skeletal *x*-rays are typical of the disease. (Fig. 8*a*, *b*, *c*, *d*, *e*, *f*.)

McCune and Bradley[14] enumerated all the cases in the literature (sixty-nine) up to 1934. Nussey[15] reported 112 cases up to 1938 and tabulated those from 1934 on. Table 1 lists the cases that have been published since Nussey's report and adds six others that he omitted. With our four patients this brings the total to 135 cases to date.

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END RESULTS OF SYNOVECTOMY OF THE KNEE JOINT*

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CREDIT for the adaptation in this country of the operation of synovectomy must be given to Swett.[7] It was he who in 1922 before the American Orthopedic Association read a paper describing the procedure and who reported synovectomy done fifteen times on eight patients with six good results, one fair result and one patient not improved. From that time on synovectomy has become recognized as a surgical procedure of value for certain types of joint conditions. Like all such procedures it has been abused in many instances and failures have resulted from it. However, we believe it has passed through the stage of experimentation and that it can now be said to be established as a surgical procedure.

Following Swett's work, some authors published experimental work to demonstrate the regeneration of synovial membrane in experimental animals. Key's work reviews experimental cases up to the time of his report (1925), and describes his own procedure of synovectomy in a series of rabbits' knee joints. After studying these joints microscopically at intervals of from two to 104 days after operation, he described accurately the changes taking place during the various stages of healing and including complete regeneration of the membrane. On the basis of this work Key concluded that in the rabbit the synovial membrane was approximately normally regenerated within sixty days after synovectomy. He stated that "The new synovial membrane is formed in situ by metaplasia of underlying connective tissue cells and there is little or no tendency for surface growth from the edges to cover the denuded area as occurs in the repair of a defect in an epithelial surface. The synovial cells are connective tissue cells slightly specialized by their location on a free connective tissue surface." Wolcott carried out a similar series of experiments in dogs, and he arrived at about the same conclusions as those of Key regarding regeneration of the synovial membrane. He believed that the synovial membrane was fairly well regenerated within thirty days and he noted that additional metaplasia was inhibited after the synovial membrane had been reformed, an action which he believed explained the absence of excessive scar tissue.

There are few instances recorded in which joints have been opened later following synovectomy in human beings. We recall one case in which synovectomy was performed a second time, thus giving us an opportunity to observe not only a regenerated membrane but also a case in which synovitis had occurred in a regenerated membrane.

In Swett's[7] original paper he stated that he believed the operation to be based on three theoretical considerations:

1. "The first theory was based upon the proposition that the surgical foci of infection having been removed, the patient's general state indicating that the activity of the inflammatory process in the joints was subsiding, and the usual means of absorption of the organized inflammatory exudate having failed, there remained the possibility that the manual removal of the exudate might promote the resumption of joint function."

2. The operation might be helpful, not alone by the mechanical improvement, but by removal of organisms capable of continuing the process.

* Read by Dr. Ghormley before the meeting of The American Rheumatism Association, New York City, June 10, 1940.

3. Stimulation of metabolism by a prompt restoration of function in atrophic disused joints and muscles might occur.

Of these various theoretical considerations, it is our opinion that only one can be said to have been realized; that is, mechanical removal of obstruction to the normal function of the joint can be accomplished by synovectomy in properly selected cases. The second consideration seems to us not to have been accomplished thus far. The third consideration is still too theoretical in nature for us to be certain of its falsity or validity.

It should be pointed out also that Swett[7] at the time (1923) recommended that the operation be used only in chronic infectious arthritis.

If all previously reported end results of this procedure are reviewed, it is found that a fairly good average from various authors is obtained. The results are well summarized by Boon-Itt. The results as obtained in Steindler's clinic are tabulated by Boon-Itt, who also reviewed the end results published up to that time (1930) by other authors. His conclusions were that in 60 per cent of cases of chronic arthritis of the polyarticular type, the patients were improved by synovectomy, whereas in the monarticular types 75 per cent of patients were improved by the operation. In traumatic arthritis the improvement was 95 per cent, and according to the author, patients who have tuberculous arthritis are not improved by synovectomy.

Painter, reporting the results of synovectomy in four cases of chronic infectious arthritis wrote: " . . . The value of synovectomy to the patient was the removal of that which had accumulated within the articulations as a result of cellular reaction to toxic invasion and, though at the time innocuous, was putting the joints at a mechanical disadvantage, too long a continuance of which might have resulted in permanent disability. That I conceive to be the *raison d'être* of synovectomy and only such cases as present that condition and probable outcome should be subjected to it."

Synovectomy is obviously best suited to the knee joint. The surgical approach to this joint is excellently adapted for very extensive removal of the synovial membrane. Other joints are much less easily approached. Although synovectomy may be done on the elbow, the wrist and the ankle, we believe it must be partial only, and that these joints cannot be considered to be surgically adapted to synovectomy except in an occasional case. The hip and shoulder are almost unapproachable for a synovectomy. We have on occasions done partial synovectomy on finger joints, but we nevertheless believe the operation to be poorly adaptable to these joints.

Swett,[8] in 1937, again reviewed the status of the operation. In this review he stated that his first and third theoretical considerations, mentioned herein previously had been fulfilled by the operation. In his summary in 1937 he stated that:

"The consensus of opinion is that synovectomy may well be employed in a joint in which extensive induration and fibrosis of the capsule, enlargement of the synovial villi, and persistent increase of joint fluid are present. Such a joint may be caused by:

"1. Chronic atrophic arthritis
"2. Traumatic arthritis
"3. Benign tumors
"4. Osteochondromatosis
"5. Syphilitic arthritis
"6. Intermittent hydrarthrosis
"7. Synovitis ossificans
"8. Hypertrophic arthritis
"9. Synovial tuberculosis
"10. Synovitis caused by foreign-body irritation."

A review of the cases of diseases of the joints in which the patients were treated by synovectomy at the Mayo Clinic has been undertaken. In this review we find that there were eighty-eight patients for whom synovectomy was performed 103 times. Table 1 shows the conditions for which the operation was done. This list includes the conditions mentioned by Swett[8] in his last paper, with the exception

of syphilitic arthritis, synovitis ossificans and synovitis caused by foreign body irritation. Having had none of these conditions represented in our group, we cannot argue as to the merits of the operation for such conditions.

The results of the operation in our series of cases are included in Table II and the

TABLE I
SYNOVECTOMY AS DONE AT THE MAYO CLINIC

Diagnosis	Joints, Number
Chronic synovitis	25
Chronic synovitis; chronic infectious arthritis later developed	15
Chronic infectious arthritis	37
Traumatic arthritis	10
Synovial osteochondromatosis	5
Intermittent hydrarthrosis	5
Tuberculosis	3
Hypertrophic arthritis	2
Xanthoma of synovial membrane	1
Total	103

Synovectomy was performed 103 times on eighty-eight patients.

There were fourteen cases in which the operation was bilateral synovectomy of the knee, and in one of these cases synovectomy of an ankle was done.

One synovectomy on the wrist was done.

percentile results are included in Table III. The results have been divided into "excellent," "improved," and "poor," and the criteria for such classification of end results are contained in the footnotes to Table II. Obviously, by a careful study of results, more gradations than these could be established, but for the sake of brevity and perhaps clarity, it seems possible to group them in this way.

On the basis of these tables it is obvious that certain conditions may be expected to respond to the operation more favorably than others. Of the conditions herein tabulated, one of most interest to us has been "chronic synovitis." All of us have seen patients who have persistent swelling of one or both knees with no evidence of any other involvement of joints. We may do everything in the way of conservative treatment in these cases with little or no improvement noted. Finally, synovectomy is recommended and done. Out of forty

TABLE II
RESULTS OF SYNOVECTOMY

Disease	Excellent*	Improved†	Poor‡	Doubtful or Unknown	Dead
Chronic synovitis	13	4	5	1	2§
Chronic synovitis; chronic infectious arthritis later developed	1	5	5	4	0
Chronic infectious arthritis	5	13	13	5	1‖
Traumatic arthritis	6	3	1	0	0
Synovial osteochondromatosis	3	2	0	0	0
Intermittent hydrarthrosis	2	0	3	0	0
Tuberculosis	0	1	2	0	0
Hypertrophic arthritis	0	2	0	0	0
Xanthoma	1	0	0	0	0

* Excellent: Pain and swelling absent except on extremes of activity; range of motion improved.

† Improved: Some pain and swelling on normal work but less than preoperatively; range of motion not improved.

‡ Poor: Pain and swelling not decreased; range of motion less

§ Deaths not attributable to synovitis.

‖ Died of shock on day of operation.

such cases in which synovectomy was done, involvement of other joints at the time of follow-up study has developed in fifteen, or 37.5 per cent. This figure seems to us significant. Perhaps with more modern,

TABLE III
PERCENTILE RESULTS

Disease	Excellent	Improved	Poor	Dead
Chronic synovitis	59.2	18.2	22.6	
Chronic synovitis; chronic infectious arthritis later developed	9.9	45.0	45.0	
Chronic infectious arthritis	15.6	40.6	40.6	3.2
Traumatic synovitis	60.0	30.0	10.0	
Synovial osteochondromatosis	60.0	40.0	0	
Intermittent hydrarthrosis	40.0	0	60.0	
Tuberculosis	0	33.0	66.0	
Hypertrophic arthritis	0	100.0	0	
Xanthoma	100.0	0	0	

improved methods of diagnosis, the differentiation between "simple chronic synovitis" and "chronic infectious arthritis" can be made, but in this group of cases it was either not made, or in some cases the

possibility of later development of chronic infectious arthritis was disregarded. But obviously such later development has occurred. In accordance with this observation, it should be noted that most of the membranes in these cases have been studied histologically and have been found to show the changes regarded by us as characteristic of chronic infectious arthritis. In an article by Deacon and one of us (R. K. G.), these cases were reported in part. In that same article, the pathologic aspects in a case of intermittent hydrarthrosis were given as follows: "a slight thickening of the lining layer of cells without increased fibrosis or perivascular thickening was all that could be seen." This observation was made concerning a specimen taken for biopsy. At the same time, reference was made to an article by Porter and Lonergan in which the pathologic changes in a case of intermittent hydrarthrosis characterized by large nodules of round cells and several sclerotic vessels were described. The condition in this case progressed to severe generalized arthritis. In all our cases of intermittent hydrarthrosis, other joints became involved subsequent to performance of synovectomy. In the two cases in which the patients obtained "excellent" results, some type of swelling later developed in the opposite knee. Krida reports two cases of synovectomy done for intermittent hydrarthrosis in which the patients apparently obtained good results. The patients had not been followed for more than a year, however, at the time the report was made.

All these data seem to us to indicate that these instances of "chronic synovitis" and "intermittent hydrarthrosis" are in reality manifestations of chronic infectious arthritis. Acceptance of such a conception seems to us necessary in viewing these facts. In the group of patients who had synovitis and in whom chronic infectious arthritis did not develop, it may be argued that prevention of the spread of arthritis was accomplished by synovectomy. This action we do not believe likely; more likely is the theory that the condition was a phase of the more widespread condition, and synovectomy eradicated the local manifestation while the spreading was either not destined to take place or the condition became "burned out," so to speak.

Our results would seem to indicate that synovectomy is most useful in traumatic arthritis, synovial osteochondromatosis and xanthoma or benign tumors. It seems to us of less value, although indicated, in some cases of chronic infectious arthritis. It is of value in chronic synovitis, but the prognosis in these cases must be guarded, as is also true of intermittent hydrarthrosis. We were surprised to find one tuberculous knee apparently improved by the operation, a result which seems to us the exception rather than the rule. We have heard of other cases of tuberculous joints in which the patients apparently were improved by synovectomy. There are, on the other hand, certainly many more failures than successes in this particular group of cases. We do not recommend synovectomy in cases of tuberculous joint disease.

Of the cases of chronic infectious arthritis in which the operation was employed, we have tried to select only those in which the active stage of the disease had passed. Such selection is at times difficult, and there may be circumstances under which the operation is indicated before a completely quiescent stage of the disease has been reached. Large, boggy synovial membranes in the knees with limitation of function of the knees obviously caused by the large membranes, joints that still have a considerable amount of motion possible in them, and cases in which a minimal amount of damage to the articular cartilage is present, constitute the indications for the operation so far as the local condition is concerned, and we have already pointed out that the general condition must be fairly good, with an apparently quiescent state of arthritis present, if synovectomy is to be performed.

Little need be said about the technic of the operative procedure itself. It is pretty

well established and understood by those using it. Some dissension is apparent concerning the importance of removal of the semilunar cartilages. In our group, one or the other semilunar cartilage was removed from twenty-one knees, and both semilunar cartilages were removed from seven knees. Inasmuch as the patients concerned in such removal would be classed largely in the group of patients who had "improved" and "poor" results, it is difficult to estimate the value of this part of the procedure. We do believe that if it is obvious at the time of operation that the semilunar cartilages are seriously damaged and that they are, in turn, causing damage to the surface of the articular cartilages, they should be removed; but insistence on removal of them in all cases of synovectomy regardless of their condition seems to us poor teaching.

An occasional patient will need manipulation during convalescence if motion does not return within a reasonable time. Judgment as to when to do the manipulation can be gained only by experience, and there may be many factors to consider. However, in general we would say that a knee that seems to lag in return of motion at the end of the second or third week of postoperative convalescence usually can be improved by manipulation performed with the patient under anesthesia.

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A NEW METHOD OF CLOSED REDUCTION OF FRACTURE OF THE LATERAL CONDYLE OF THE TIBIA

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WITHIN the past ten years a previously rare fracture type has come to the fore and much has been written relative to it. This is the fracture of the outer side of the tibial plateau produced by abduction of the leg forcible enough to smash this external tuberosity against the fulcrum of the outer condyle of the femur. Such a fracture may be sustained by falling downstairs, but the advent of the automobile, especially recent models with a lowered bumper has furnished a simpler, and, as Cotton in his inimitable manner stated, "a more fashionable way" of doing it. When the tire, fender or bumper strikes the extended standing leg, something must give way. This may be the outer condyle of the femur but not infrequently it is the internal lateral and other ligaments. As a rule, however, the tibia gives way first, and the limb is bent into a knock-knee deformity. It is a crushing fracture which if neglected or kindly treated, results in a genu valgus deformity, sometimes extreme, with much instability and uselessness. Campbell[3] has very aptly likened it to a compression fracture of a vertebra.

Wilson,[7] Cotton[4] and others have suggested the name "fender" or "bumper" fracture for this type of injury, and Cotton never ceased to teach that in comminuted fractures of this type, closed reduction is the method of choice, the rationale being reversal of the causative mechanism. Though not comfortable, the particular method he first advocated (Thomas splint with Pearson screw-pad plates, digital molding, etc.) could be tolerated, and it worked. In later years he used casts.

Campbell,[3] Cubbins,[5] Watson-Jones[6] and many others agree with Cotton that closed reduction is the procedure of choice and that the knee joint must be placed in as much varus as possible, but admit also that the optimum degree of varus is rarely achieved or maintained. Despite the pressure pad over the mesial supracondylar aspect of the femur, pushing laterally, and another below the fibular head (usually crushed) pushing medially, or modifications thereof, and in spite of the dozen hands that are ready to assist the surgeon in molding and applying the cast (hands that are more often in the way than of actual help), the cast when finished has not produced the amount of varus intended and does not maintain reduction.

As Cubbins points out, "There remains a certain amount of genu valgus in most of the cases, irrespective of how perfect the *x*-ray picture has been or how satisfied one has been with the technique." The torn lateral ligaments though united have probably done so with lengthening.

It is this lack of a means to attain and maintain varus which has caused so many surgeons to disregard closed reduction in favor of open reduction despite the fact that at operation one usually finds no major fragment to work with, nothing to pin into place. The comminuted bone, when exposed, is like cracker meal and elevation osteotomies from below are wholly inadequate to replace and properly mold back a tibial plateau. Surgical exposure removes the supporting "envelope" about the "bag of meal" and so the surgeon actually defeats his own purpose. It is to be noted that we are *not* referring to that type of fracture of the external condyle of the tibia in which a relatively solid block of bone has split off, in which case most authorities (Caldwell[2]

being a notable exception) seems to agree that a steel bolt should be used to fix in position, having little apparent regard for the torn ligamentous sustentaculum of the knee joint.

Because of the difficulties associated with open reduction, just cited, which seem to us to constitute a greater objection to it than its flaws do to the closed method, we have generally adhered to the latter procedure. In doing so, a method of getting and maintaining the desired degree of varus and of mesial upward replacement and molding of the depressed tibial plateau has suggested itself on the basis of a mechanical measure of proven value in other orthopedic situations. This has now been utilized by us in five cases with such successful result that we are presenting the method at this time. The procedure is as follows:

TECHNIC

Without attempt at reduction or correction of the fresh fracture and *with the leg in complete extension*, a carefully padded, snug-fitting cast is applied, extending from the toe tips to the groin. Particular attention is paid to padding the outer upper aspect of the thigh and the mesial aspect of the knee. In the cast are incorporated a pair of ordinary hinges—one anteriorly and the other posteriorly—eccentrically placed and bent at about a 30° angle, convexity mesialward, with the apices centered over the knee joint proper. (Fig. 1.)

At the end of three or four days, the cast is thoroughly dry and the patient has generally recovered from the mental and physical shock attending the trauma that brought him into the hospital and has become acclimated to his new environment.

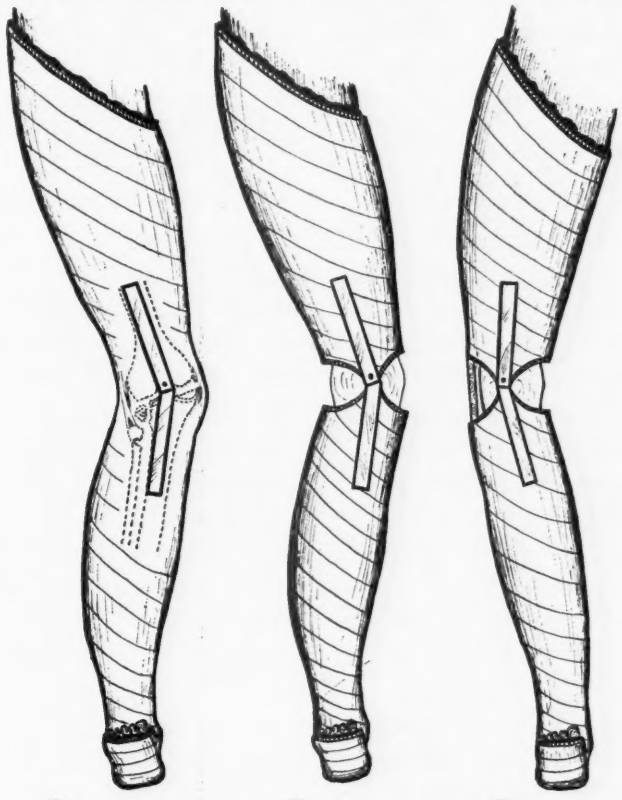

Fig. 1. Fig. 2. Fig. 3.

Fig. 1. Actually, the hinges are incorporated within the body of the cast.

Fig. 2. The inner elliptical and lower lateral cut outs should be made somewhat wider than illustrated.

Fig. 3. The final wood-block strut is not as proximal to the knee as is drawn.

Elliptical pieces of the cast, including the underlying sheet wadding and felt, are then cut out completely exposing the knee. (Fig. 2.) Sedation is now given (morphine sulfate plus scopolamine) supplemented with gas-oxygen anesthesia if required, and the leg placed in as much varus as desired. A wood block of necessary length is inserted, "strutted" against the lateral cuts of the cast edges at the *posterior lateral aspect.*

With the knee joint in full view and under complete control, a rubber block is placed under the lowermost edge of the comminuted mass and successive blows are made with a solid rubber mallet in an upward direction, followed by compression with a narrow furniture clamp (the jaws of which are protected with felt), digital molding and palmar compression. Care is exercised, of course, to avoid pressure on the external popliteal nerve. A Watson-Jones clamp. Boehler's redresseur,[1] Caldwell's "nut-crackers" or any other method could be used with equal facility.

A check roentgenogram should be taken in each instance and further reduction accomplished as indicated. This was necessary in only one of our five cases. The initial wood block strut as well as a similar piece "strutted" more anteriorly are left in situ. (Fig. 3.) The elliptical spaces are then filled in with sheet wadding and a plaster of paris cuff is applied so as to encircle the whole.

In our five cases the period of absolute immobilization was ten weeks and vigorous quadriceps exercises were instituted ab initio in every case. Following the removal of the initial wedging cast, a snug-fitting, unpadded cast was applied to maintain the varus and then bivalved, both shells being reapplied with straps upon retiring. During waking hours the patient wore a full length *ischial rest* brace with a leather cuff above the knee encircling the lower thigh and fastened to the lateral upright bar and another below the knee, fastened to the medial upright bar. Knee flexion exercises were practised especially just prior to application of the sleeping cast.

Active weight-bearing was allowed *not sooner* than six months after original reduction. Although healing takes place during the first ten weeks, the callous about the cancellous bone remains spongy, so that *active* weight bearing even with a varus brace will cause an impacting cupping depression. It must not be forgotten that this is the weight bearing condyle.

The final results were very gratifying. Three cases were seen twelve, sixteen and nineteen months, respectively, following the original traumas and one case nine months afterward. In every instance the normal anatomical outline of the knee was excellent and each patient had a full range of extension and flexion with no pain whatsoever. The fifth patient (seventeen months afterward) could not be contacted in spite of diligent search.

The method is applicable to a fracture of the condyle in which a solid piece of bone has cracked off as well as to the comminuted type of fracture.

CONCLUSIONS

A new method of closed reduction of a fracture, particularly a comminuted fracture, of the lateral condyle of the tibia (bumper or fender fracture) is presented.

It is recommended because of its ease of application, because it affords the surgeon an opportunity to keep the fracture and cast under complete control, and makes possible the obtaining and maintaining of any desired amount of varus.

The method has proved eminently satisfactory in all of the cases in which the author has utilized it.

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COLOSTOMY AND ILEOSTOMY: A NEW METHOD*

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A PROPERLY performed colostomy is a relatively safe and simple surgical procedure. Through regulation of the bowel movement by a suitable diet, such a colostomy is tolerated by many individuals. Nevertheless, the fear of an unexpected escape of feces or flatus at a most inopportune time hangs like the "Damocheles sword" over the heads of any colostomized individual. There are patients who are never reconciled to an uncontrollable, artificial anus and who remain invalids for the rest of their lives.

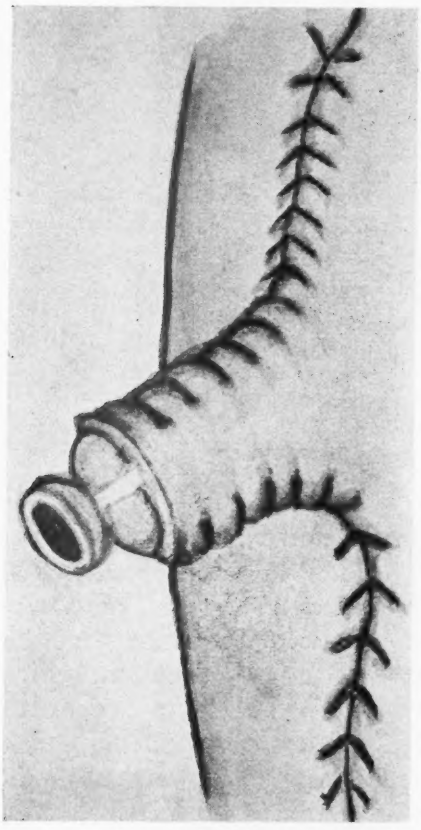

FIG. 1. A projecting loop of bowel surrounded by skin. A technic elaborated by the author and published in *Annals of Surgery* in 1926 and 1927. (Steinberg, M. E. A skin-flap colostomy. *Ann. Surg.*, 85: 315, 316, No. 2, February, 1927.)

Numerous surgical procedures have been advanced with an object to improve the control of a colostomy. None have become popular because these methods are either unsatisfactory or altogether too complicated. The method of Kurtzahn and Haecker aim to establish a skin-lined tunnel under the bowel through which the bowel can be compressed by a rubber tube. Such operations are major procedures of plastic surgery performed in the presence of fecal contamination. The increased morbidity and mortality alone would prevent its routine adaptation. The promised control and convenience is questionable. Any other manner of muscle control or narrowing and twisting of the lumen is unsatisfactory

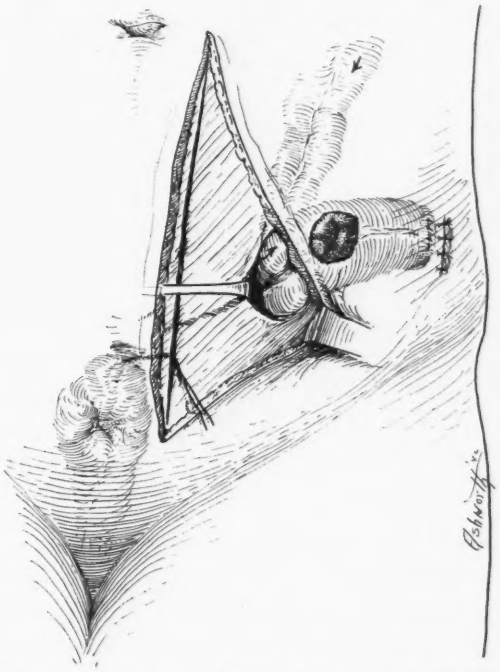

FIG. 2. First plan: A closed loop of bowel placed under the skin. Opening made in the middle of bowel.

* From the Emanuel Hospital, Portland, Oregon.

because it produces an impediment to the free flow of fecal contents.

Several years ago I fashioned a skin flap and formed into two parallel loops sutured to each other as shown in the illustration. Later the diaphragm was crushed as in a Mikulicz operation. The end results gave a pocket under the skin which holds a considerable amount of feces. (Fig. 4.)

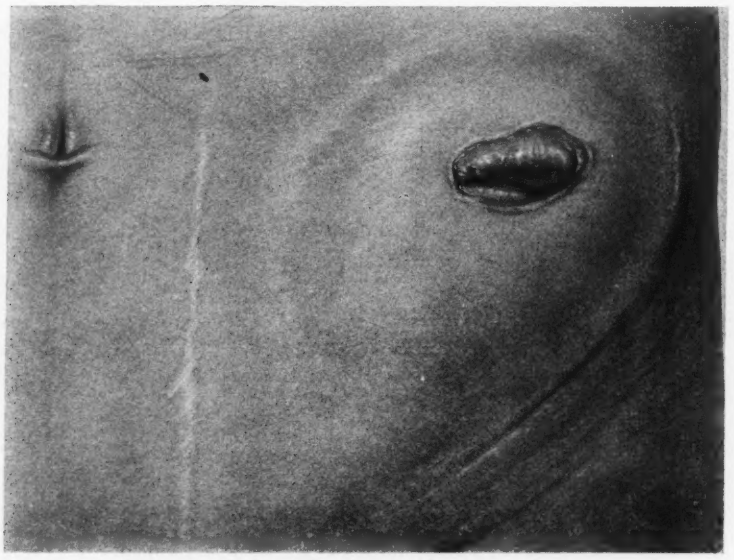

Fig. 3. A drawing of the colostomy (plan one) as it appears nine months after the operation. The feces accumulate in the receptacle. Occasionally there is an involuntary escape but frequently the contents are evacuated by manual manipulation. Patient eighty years old; two-stage resection of the carcinoma of the rectum.

around the protruding bowel and named this method the "Skin-Flap Colostomy." It promised no control of the fecal flow. The protruding bowel surrounded by skin emptied into a cup. This resulted in less frequent soiling of the surrounding skin than in the usual type of colostomy. (Fig. 1.)

In the last three consecutive colostomies I have gradually evolved a plan which is presented here. The first plan simply consisted in bringing the closed proximal loop of the sigmoid through a tunnel made under the skin. Such a procedure is described in Kirshner's textbook. Only, instead of opening the terminal end of the bowel, I proceeded to make the opening in the middle. This modification fashioned a proximal and distal loop which ended blindly. Such a colostomy does not only hold a fair amount of feces but can be compressed at each end by a mechanical appliance. (Figs. 2 and 3.) In the second consecutive colostomy the bowel, closed at one end, was also pulled out under the skin

The third method aso includes the formation of a bowel segment which opens at the skin level with its peristaltic action directed toward the pouch. This technic was used on the last patient and is presented in detail.

TECHNIC

The abdomen is opened through a lower, left rectus or a lower midline incision for the performance of a colostomy. Either the lower midline incision or the right, lower rectus incision may be used for the performance of an ileostomy. When performing a colostomy, as in the first stage in the removal of malignancy of the rectosigmoid or the rectum, the sigmoid is divided above the tumor. The proximal sigmoid loop is freely mobilized by incising the peritoneum on the left side. The sigmoid loop should be long and freely movable and should have a good blood supply. A transverse incision

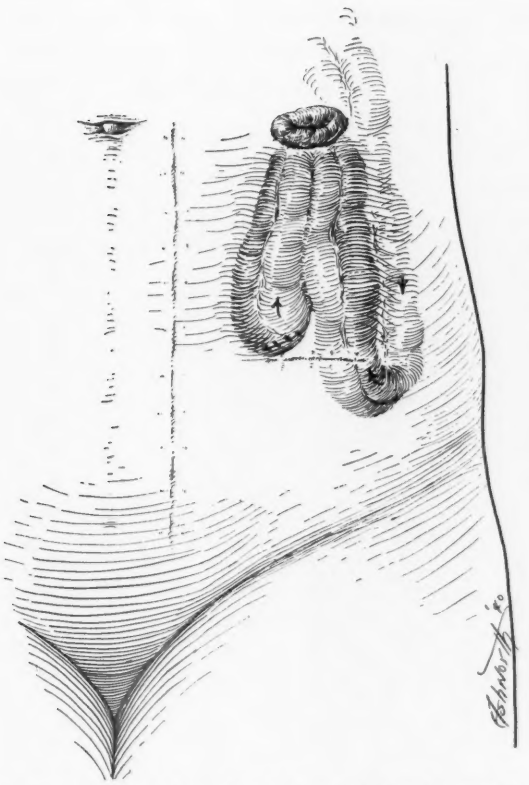

Fig. 4. Second plan: Both loops of bowel brought under the skin and the spur crushed at the upper extremity. Feces accumulate in the pouch under the skin. Involuntary escape of feces is controlled by diet and enema. Some of the feces accumulate in the pouch and are evacuated by manual manipulation. Patient seventy-eight years of age; first-stage of resection for carcinoma of the rectum.

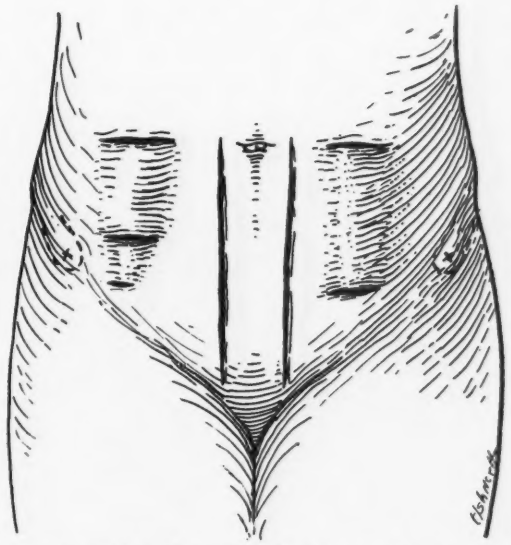

Fig. 5. Third plan: The incisions used for the performance of ileostomy and colostomy.

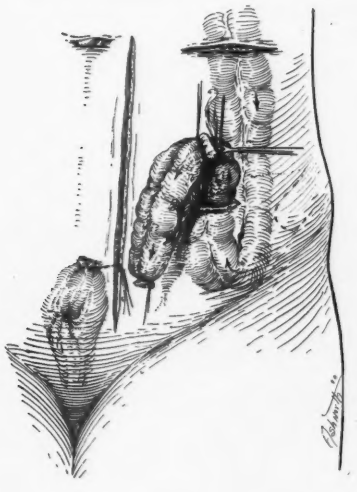

Fig. 6.

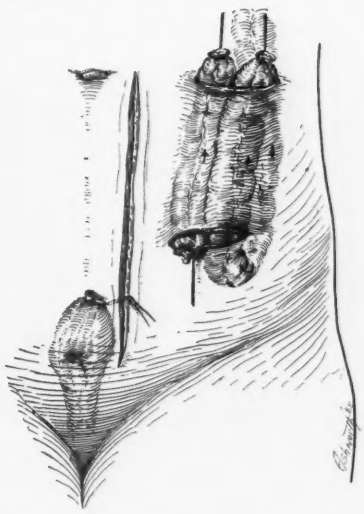

Fig. 7.

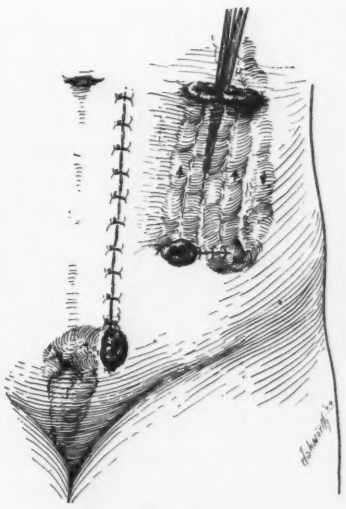

Fig. 8.

Fig. 6. Third plan: The sigmoid has been brought out through the lower transverse incision. A terminal loop closed at each end has been fashioned. The peristaltic action in the terminal loop of the sigmoid is directed downward.

Fig. 7. Third plan: Both loops of the sigmoid have been pulled through the tunnel under the skin. The terminal loop of the sigmoid has been turned 180 degrees so that the peristaltic action is now upward.

Fig. 8. Third plan: Clamps applied to connect both loops for the formation of a receptacle.

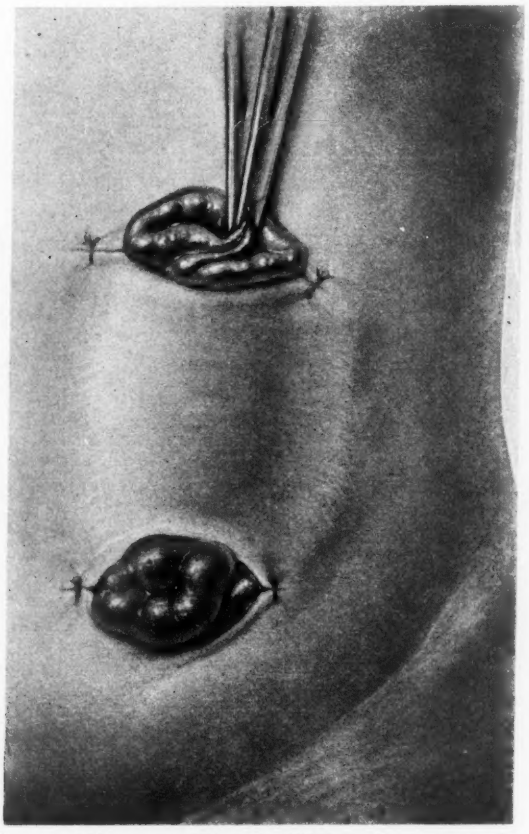

FIG. 9. (Same as Fig. 8.) Third plan: Actual drawing of the incomplete colostomy. Patient eighty-two years old; colostomy opening at the upper incision should be ready for closure after six weeks.

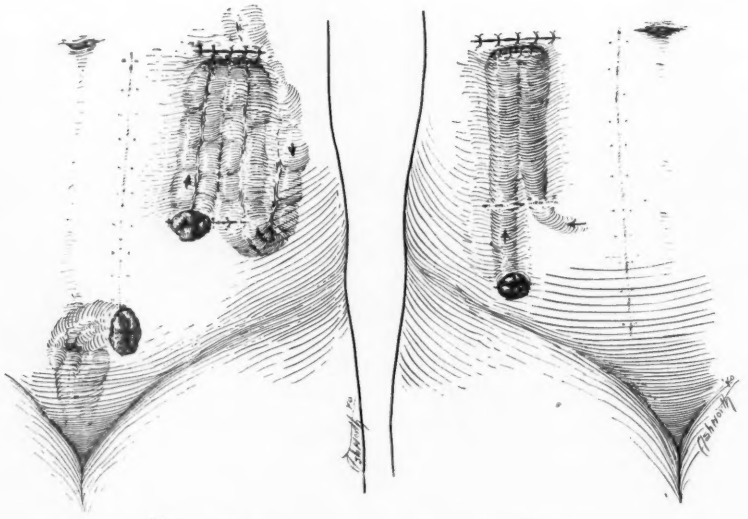

FIG. 10. FIG. 11.

FIG. 10. Third plan: A receptacle has been formed under the skin and is connected to the outside by a loop of bowel at the lower incision with its peristaltic action pointed upward.

FIG. 11. A diagrammatic sketch of completed subcutaneous ileostomy.

about 6 cm. long is made at the level of the left anterior superior ileal spine between the spine and the midline. This incision penetrates all the layers of the abdominal wall including the peritoneum. Another transverse incision which is a little longer than the lower one is made about 8 to 10 cm. above the last incision and parallel to it. The upper transverse incision penetrates through the skin only. The skin between the upper and lower incisions is undermined. The sigmoid loop intended for the colostomy is divided fashioning a distal loop measuring 10 to 12 cm. and closed at both ends. Both loops of the proximal sigmoid are pulled through the lower transverse incision and through the tunnel made under the skin. The distal loop of the sigmoid which is closed at both ends is turned 180 degrees. Both loops are approximated by a few sutures of fine catgut. In spite of the turning of the distal segment there was no strangulation of its blood supply. The propelling action of peristalsis in the distal segment is now directed cephalad. The vertical incision is closed and protected from soiling. The loops of the bowel are opened immediately at the upper transverse incision. The bowel protruding at the lower transverse incision can be opened later. The protruding loops are surrounded by vaseline gauze. A few stitches are used to close the skin around the loops of the protruding bowel.

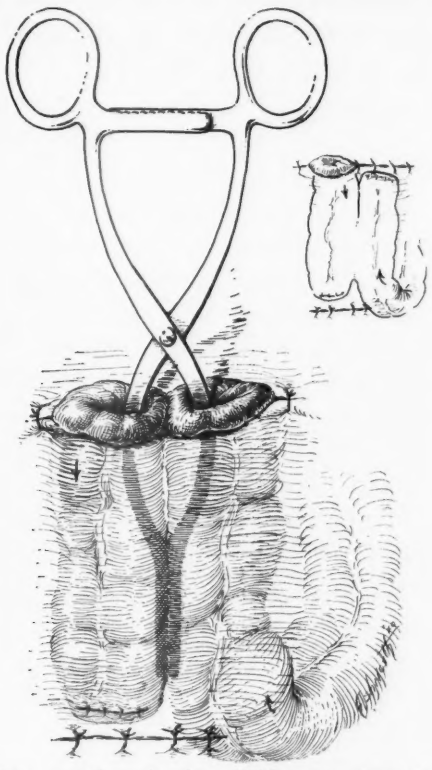

Fig. 12. Fourth plan: This procedure is similar in principle to the third plan of action but is considerably simplified. The distal loop of bowel is not turned on its axis. A special crushing clamp is applied leaving parts of both loops of the bowel intact at the upper incision. The bowel on the left is eventually closed. This receptacle opens by a retroperistaltic loop on the right at the upper incision. Insert: A diagrammatic view of the completed operation.

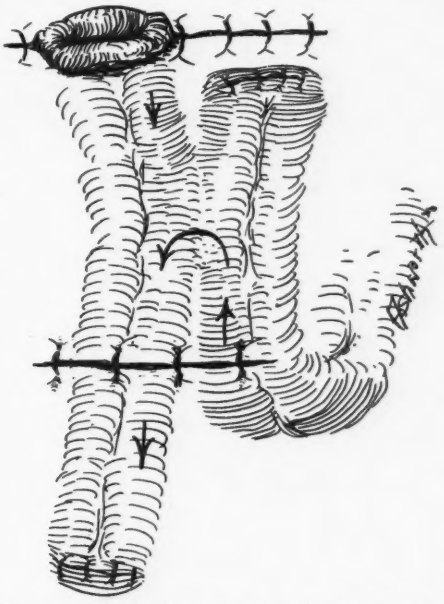

Fig. 13. Fifth plan: A plan similar to the one represented in Figure 14. The distal loop is longer, thereby assuring more capacity for the subcutaneous receptacle.

On the sixth or seventh day crushing clamps are applied to both loops at the upper transverse incision. These clamps should be applied close to the skin in order not to include blood vessels in the mesentery. The patient is sent home for about six weeks to allow for good healing. Both loops which now form one lumen are closed in the same manner as in the second stage of the Mikulicz operation. In this manner a pouch is formed under the skin which empties through the colostomy opening in the lower

incision. The peristaltic action of the short loop of bowel at the lower transverse incision is now directed toward the pouch. The

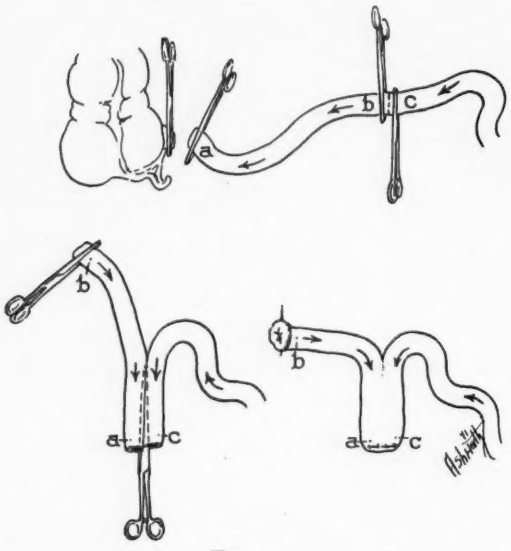

FIG. 14.

fecal contents accumulated in the pouch can be emptied voluntarily by raising the intra-abdominal pressure and by manual pressure of the overlying skin.

As already mentioned, three consecutive colostomies have been performed similar in nature. The first two were only the preliminary steps to the one described here. A pouch was fashioned which did not include a retroperistaltic loop. Both of these patients have a better degree of control than in the usual loop colostomy. Feces accumulate under the skin and can be evacuated by increased intra-abdominal pressure and by manual manipulation over the skin. The patient upon whom the complete operation here described was used has not yet reached the final stage. However, no feces escape through the lower retroperistaltic loop of bowel which has been kept open.

The application of this plan of action to a permanent ileostomy should be of particular interest and importance. While a well planned and well cared for single loop colostomy is frequently compatable with little annoyance, an ileostomy, on the other hand, is a most distressing condition. The skin is frequently eroded. The continuous escape of fluids and electrolites keep the patient in a poor state of health. This plan of action applied to an ileostomy should be more feasible since a longer retroperistaltic terminal loop can be utilized.

It is questionable whether a similar pouch constructed inside of the abdominal cavity could function in the same manner as in the method described. An immediate, direct anastomosis formed inside of the abdomen or under the skin would entail danger of infection and peritonitis. By the use of the technic presented in this paper, infection of the abdominal wall should not present much of a problem. Out of the three colostomies there was necrosis of the subcutaneous tissues in one patient. The patient had diabetes. The necrosis was probably due to too extensive undermining of the skin and the use of too generous an amount of local anesthetic. However, if the blood supply of the distal loop should ever become strangulated, it would be a simple matter to remove a small part of the gut or to convert this type of colostomy or ileostomy into the standard method without endangering the life of the patient. The introduction of a rectal tube during the first postoperative days should be used with caution since the course of the bowel is longer under the skin. No difficulty has been encountered with the bowel evacuation in all of the three colostomized patients in the first few days after the operation.

Variations in technic and other problems of after-care will present themselves for solution as one gains experience in the application of these procedures.

One of the variations is pictured in Figure 12. The distal loop is not turned. A special clamp is used to make the anastomosis in the lower part of the parallel loops of bowel. The eventual colostomy or ileostomy also opens by a retroperistaltic loop which is, however, placed in the upper transverse incision. This plan is not only simpler but also safer since there is no danger of strangulation of the blood supply from twisting of the bowel.

Still another deviation from the one described is the formation of a long subcutaneous loop closed at its distal extremity. The peristalsis carries the fecal flow toward the long, closed loop of bowel. (Fig. 13.)

Since sending in the manuscript to the publishers, two more colostomies have been performed using the technic depicted in Figure 14. The transverse incision through all the layers of the abdominal wall is now made above the transverse incision which penetrates the skin only. This variation in technic brings the temporary colostomy opening in a straight continuous line with the descending colon and, therefore, permits an easy introduction of the rectal tube. Only the actual performance of such a colostomy is able to demonstrate that there is a minimal or no twisting at all of the mesentery.

While it is doubtful whether such a colostomy could be placed inside the abdominal cavity, this may not be the case when performing an ileostomy since the fecal contents passing through an ileostomy are liquid or semisolid. The placing of an ileostomy pouch inside of the abdominal cavity should be of some advantage since it would require a minimal undermining of the skin. An ileostomy pouch placed directly under the skin may also be subjected to some involuntary escape from pressure or movement.

An umbilical sinus from which there is a repeated discharge of mucus or other fluid should at once arouse suspicion of a Meckel's diverticulum communicating with the navel. Insertion of a small catheter into the fistula, instillation of a bit of lipiodol, and roentgenologic study may give important information concerning a communication with the intestine and thus rule out a patent urachus, which would connect with the urinary bladder.

IRON AS A THERAPEUTIC SUPPLEMENT IN PEPTIC ULCER THERAPY*

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UTILIZING the therapeutic properties of colloidal aluminum hydroxide, a means of administering a nonirritating form of iron for the treatment and prevention of anemia in patients with peptic ulcer is presented. It is offered as a means of combating and abolishing the several factors inherent in the present concepts of therapy which favor the production and maintenance of an iron deficiency state.

In many cases, actual blood loss by slow chronic bleeding or frank hemorrhage requires vigorous and persistent measures to achieve relief of the anemia. Unfortunately, adequate therapy with inorganic iron is difficult to obtain since so many of the available pharmaceutical preparations have a definite local irritating effect.[1] Even if this were not so, the concomitant alkaline therapy would seriously interfere with the utilization of iron supplied either in the diet or by therapeutic preparations. Kellog and Mettier[2] demonstrated "that an iron-rich diet had practically no effect on the formation of hemoglobin during the period of alkalization but that after administration of alkalies was stopped, it had a marked effect comparable to that produced by adequate therapy with inorganic iron." Finally, milk, which holds a leading position on most dietary régimes, cannot support proper hemoglobin levels in human beings,[3,4,5] while the character of the supplementary foods commonly used with milk are not such as to supply enough iron to make up the deficiency.

Our problem, therefore, concerns itself, first, with the means of controlling the gastric acidity without production of alkalinity, and, second, in finding an iron preparation nonirritating to an already hyperirritable or ulcerated gastrointestinal mucosa. Colloidal aluminum hydroxide is unquestionably our answer to the former. It counteracts excessive acidity by neutralization and also to a small extent by adsorption, but cannot produce a state of alkalinity. Lowering the gastric hydrogen ion concentration may interfere with utilization of iron, but absence of hydrochloric acid by itself has no appreciable effect on iron retention or hemoglobin regeneration when large amounts of iron are administered.[6] Furthermore, the "coating" or demulcent effects of aluminum hydroxide may protect the ulcer area from irritating medications.

It is probable that iron in a colloidal form would be the least likely to produce irritation to the gastrointestinal tract. A combination of the colloidal hydroxides of iron and aluminum has been recently introduced under the name of feralumina.† This substance consists of approximately 3 per cent aluminum hydroxide and 1.4 per cent iron hydroxide. The iron content is equivalent to 30 mg. (½ gr.) of metallic iron per teaspoonful. In other words, each teaspoonful contains the approximate equivalent of 0.13 Gm. (2 gr.) of ferrous sulfate or 0.20 Gm. (3 gr.) of iron ammonium citrate. The iron hydroxide in this product is in the colloid gel form and being soluble in dilute acid serves also as an antacid in a fashion similar to that of aluminum hydroxide.

This study, therefore, attempts to determine the answer to two questions: (1) Is the iron of this preparation nonirritating to

† Feralumina and its iron free counterpart, Lactalumina, were supplied by Crookes Laboratories, Inc., New York.

* From the Department of Medicine, New York University, College of Medicine and the Third Medical Division, Bellevue Hospital, New York City.

the gastrointestinal tract of patients with peptic ulcer? (2) Will the aluminum hydroxide interfere with the absorption of the iron?

METHOD

Forty-five patients, who had pain referable to an acute or an exacerbation of a chronic peptic ulcer were chosen for study. Patients with a previous history of gastrointestinal surgery or with any other major illness were excluded. Roentgenographic studies revealed that thirty-eight patients had an ulcer of the duodenum, three showed a gastric ulcer and four had both types. One patient gave a history of ulcer pain of less than a year, four had pain for two years and forty for more than three years. All of the patients had been on a medical routine consisting of standard ulcer diets and alkaline powder with varying degrees of relief, but because of neglect, inability to control their environment or factors beyond the scope of medical therapy recurrence of symptoms was common. Thus all patients had pain as the predominant symptom at the time of their inclusion within this study. Six of eight patients previously treated with colloidal aluminum hydroxide preferred it to an alkaline powder. One of the two patients, who had had some form of iron therapy, could not tolerate it.

A bland diet, equivalent to the sixth, seventh and eight week diet of the Sippy régime, was maintained throughout. Patients were seen at weekly intervals at which time they were carefully questioned regarding abdominal distress. Particular attention was paid to pain, nausea at the time of taking the medication, vomiting, eructation, abdominal distention and bowel habits. Weights were recorded at each visit. During the control period, all patients were given, in doses of 10 cc. four times a day, a colloidal aluminum hydroxide preparation which was identical with feralumina with the exception of colloidal iron hydroxide. After three or four weeks (in two patients, five and six weeks, respectively), feralumina was substituted and continued in the same dosage for at least five weeks. This dosage was equivalent to 0.240 Gm. (4 gr.) of metallic iron daily or 1.04 Gm. (16 gr.) of ferrous sulfate. Red blood counts and hemoglobin (Sahli) determinations were done by the same technician* before and during the period of treatment with feralumina. In nineteen patients, at least two determinations were done before, while thirty-eight patients had two or more counts at intervals of from one to three weeks after instituting the iron preparation.

As a further check on the absorption of iron, a second group of patients was chosen who had a more pronounced degree of hypochromic anemia. For this purpose eleven patients were studied on the Gynecological Service,† Third Division (N. Y. U.), Bellevue Hospital. All these patients had had some form of pelvic infection which had subsided when this investigation was started. Care was taken to exclude patients with recent hemorrhage, since in such the reticulocyte count rises spontaneously. A regular ward diet, but lacking in meat, was maintained throughout. With the exception of sedatives no other medication was used. Reticulocyte counts were done daily for thirteen or more days. On the fourth day, feralumina in 10 cc. doses four times daily was started. Red blood cell counts and hemoglobin determinations were done on the first, fourth and thirteenth days.

RESULTS

Both groups of patients tolerated the iron and aluminum hydroxide preparation without any subjective complaints of nausea and vomiting following the medication. Relief of the ulcer pains was attained without difficulty and within a period of time commensurate with the experience of other aluminum hydroxide preparations. None of the patients experienced diarrhea as evidence of intestinal irritation, but six

* The authors are grateful to Miss Judith Gideon of the Department of Clinical Pathology.

† Permission to use these patients was obtained through the courtesy of Dr. William E. Studdiford, Director of Service.

TABLE I

BLOOD AND STOOL STUDIES OF 45 PATIENTS WITH ULCER

Patients	Weeks with Lactalumina						Weeks with Feralumina									Benzidene Reaction
	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	
1			5.92–15.8			5.7–16.5			6.07–17.0							Pos.
2			4.97–15.2				5.09–16.1			5.43–15.8		5.34–15.1				
3			5.22–15.2			5.33–14.0			5.22–14.2		5.95–13.4		5.7–14.1			
4						4.54–13.0	4.7–13.1	5.01–11.83		4.74–12.3						
5			4.0–11.9		4.12–12.7				4.09–12.8							Pos.
6				4.80–14.0				4.44–13.4		5.45–13.7						
7					5.15–12.8	4.76–13.		4.49–12.2								Pos.
8				4.83–13.6				5.17–14.8								
9						3.64–11.8	3.84–11.5		3.94–12.6		3.78–12.6					
10				4.8–14.2			4.76–12.9		4.78–14.8		5.18–14.5					
11				5.07–			5.36–13.8	5.08–13.7		5.5–15.3		5.24–16.0				Pos.
12				4.63–11.5		4.40–11.8				4.85–13.2		4.43–11.9				Pos.
13					5.53–13.8			5.05–14.5								Pos.
14						4.77–15.0		4.95–15.8		5.27–16.3						
15					4.93–14.2		5.27–14.5	5.30–16.5		5.59–15.3		5.42–15.3				
16					5.48–13.5		5.05–13.7		4.96–13.1		5.39–13.4					Pos.
17				4.76–13.5			4.83–12.8	5.10–13.8		5.47–12.4						
18				4.02–9.8		4.01–9.6		3.92–10.3		4.08–10.9						Pos.
19				4.92–9.8		4.72–8.88		5.16–9.9	4.97–10.2		5.89–12.5					
20				4.46–13.5		4.41–12.9	4.66–12.9			4.77–13.5						
21				4.79–12.7			4.96–12.3		5.48–13.0		5.53–13.2		5.0–13.2			
22				5.15–15.1		4.85–14.0	5.55–13.6				5.40–14.1					
23				4.55–11.7		4.65–11.5		4.45–12.1		4.0–11.1		4.06–11.9				Pos.
24						5.02–14.1		5.12–14.2		5.45–14.1		5.25–14.2				
25				3.57–9.0			3.84–7.9				5.07–9.7		4.67–11.0			
26					5.07–12.9					5.69–14.9		5.66–16.5				Pos.
27					5.02–15.1	4.95–14.6		5.2–14.0		5.54–14.1		5.44–13.2				Pos.
28					4.65–12.3		5.56–13.0		5.32–12.7							
29					5.0–13.3		5.33–12.9		5.16–12.6		5.35–14.5		5.49–14.5		5.48–14.1	
30					5.02–14.9		5.14–14.2		5.11–14.1			5.08–14.8				
31					4.48–10.9		4.76–10.2		4.5–9.7		4.38–11.5		4.63–12.3		4.69–12.3	Pos.
32					3.96–12.0		4.73		4.14–13.1			4.16–13.6				Pos.
33		4.23–10.2		4.0–10.9		4.18–10.9		4.08–11.0		4.10–10.2			4.16–10.6			
34				5.23–11.7			5.39–13.4			5.11–13.2		5.08–14.6				Pos.
35				4.10–8.7		3.88–9.5	4.05–10.2		4.35–9.4		4.13–10.8		3.93–9.8			
36					4.74–12.1		5.37–13.6			5.42–14.6		5.61–14.9				
37					5.04–12.1		5.6–14.5				5.52–15.3					
38				5.27–11.5		5.04–10.5	5.47–11.5			5.43–11.9		5.41–12.6				
39				4.76–11.7		4.64–14.8		5.02–13.4	4.54–13.0			4.51–13.7				Pos.
40					5.06–15.8		5.46–15.3			5.79–15.3		5.36–15.3				
41				5.66–15.1		5.48–16.0		5.49–15.5								
42					5.54–14.4	5.27–15.2		4.98–15.5		4.99–14.5						
43				4.73–14.0		4.67–13.2				4.89–12.7						Pos.
44	4.94–11.5				4.05–10.6			4.47–11.7		5.2–12.6						
45					5.07–14.0		5.10–13.5			5.09–14.1						

noted a mild laxative effect. Any constipating effect is now under investigation and will be reported upon later.

ence of occult blood in the stool during the investigation, failed to show an increase in red blood cells or hemoglobin values.

TABLE II

EFFECTS ON RED BLOOD CELLS AND HEMOGLOBIN AFTER ADMINISTRATION OF COLLOIDAL IRON AND ALUMINUM HYDROXIDE IN A GROUP OF FORTY-FIVE PATIENTS WITH ULCERS

Change in Red Blood Cells of Greater than 250,000 Cells per Cmm.								Change in Hemoglobin of Greater than 1 Gm.							
Initial Red Blood Count per Cmm.	Number of Patients	No Change		Rise		Fall		Initial Hemoglobin in Gm.	Number of Patients	No Change		Rise		Fall	
		Number of Patients	Per Cent	Number of Patients	Per Cent	Number of Patients	Per Cent			Number of Patients	Per Cent	Number of Patients	Per Cent	Number of Patients	Per Cent
5.M. <....	19	5	26	10	53	4	21	14 <.....	15	10	67	3	20	2	13
4–5 M.....	22	6	27	14	64	2	9	12–14.....	17	10	59	7	41		
3–4 M.....	4	2	50	2	50			< 12.....	13	5	38	8	62		
Total....	45	13	29	26	58	6	13	Total....	45	25	56	18	40	2	4

The effects on the blood of the forty-five patients with ulcers are presented in Tables I and II. Although the majority of these patients did not present an anemic picture at the time of their inclusion in this study, the results indicated definite absorption of the iron. Fifty-eight per cent (twenty-six patients) of the group as a whole showed an increase of 250,000 red blood cells per cmm. or more, while the red blood count of 29 per cent (thirteen patients) remained unaltered and 13 per cent (six patients) decreased. The per cent of rise is slightly greater in the group with an initial red blood count of between 4 and 5 million than the group above 5 million. Forty per cent (eighteen patients) of the forty-five patients showed a rise in the hemoglobin level. However, as expected, when the level of hemoglobin at the start of feralumina is considered, the group with the lowest level presented the greatest rise. This is of greater significance since iron utilization is reflected in a rise in hemoglobin rather than a change in red blood count.

It is interesting to note that thirteen of the sixteen patients who had a marked positive benzidene reaction indicating the presNevertheless, only six patients showed a drop in their red blood count and two had a drop in their hemoglobin levels.

Results in the group of patients with hypochromic anemia are summarized in Table III. All eleven patients showed a rise of from 1 to 6 per cent in the reticulocyte count on the second to the sixth day after the iron preparation was started. While the trend of the red blood count and hemoglobin values was upward, the test period was too short to attach any real significance to these figures.

DISCUSSION

Since all of the patients with ulcers could tolerate the iron and aluminum hydroxide preparation without abdominal distress, it is evident that the preparation is nonirritating. Whether or not this is due to the colloidal form of the iron or the "protective" action of the aluminum hydroxide cannot be answered at the present time. However, it appears likely that both factors contribute to its bland nature.

Whatever action colloida aluminum hydroxide may have on the gastrointestinal tract, it apparently does not interfere with

the absorption of iron from this combination. It is of interest to note that Batterman and Rose[7] have recently shown that

TABLE III

Patient	Red Blood Count at Onset	Hemoglobin in Gm. at Onset	Reticulocyte Peak before Iron—Per Cent	Reticulocyte Peak after Iron—Per Cent	Red Blood Count after Ten Days of Iron	Hemoglobin after Ten Days of Iron
1	2.68	6.74	2.1	6.3	3.43	9.4
2	3.15	7.76	1.7	7.2		
3	3.49	9.9	0.6	1.7	4.01	11.0
4	3.29	10.2	1.2	3.7		
5	3.52	10.7	0.4	1.3	3.97	11.5
6	3.99	10.9	0.2	1.7		
7	3.87	10.9	0.3	1.7	4.24	11.7
8	3.91	11.0	0.7	2.3	3.94	10.9
9	3.70	11.1	0.9	1.8	3.89	11.8
10	4.12	11.2	0.2	1.0	4.16	12.5
11	3.97	11.9	0.9	1.9	3.94	11.7

novatropine is also readily absorbed from a colloidal aluminum hydroxide suspension. The rise in the reticulocyte count in the second group of patients definitely indicates the absorption of the iron. Not only is the degree of response in direct proportion to the degree of anemia, but it is also what might be expected if an equal amount of inorganic iron were given to patients with a similar degree of anemia. The rise of red blood counts and hemoglobin levels in the ulcer patients may not appear striking because of the large number of patients who did not present an anemic picture at the time of inclusion in this study. It is significant, however, that in almost all patients with a positive benzidene reaction of the stool we were able to maintain red blood counts and hemoglobin at a constant level.

In conclusion, the combination of colloidal iron and aluminum hydroxide offers definite advantages over plain colloidal aluminum hydroxide. It allows not only for the treatment of the peptic ulcer per se, but also the institution of adequate iron therapy in a nonirritating form in those cases requiring such medication.

CONCLUSIONS

1. Colloidal iron hydroxide in combination with aluminum hydroxide is nonirritating to patients with peptic ulcer.

2. Aluminum hydroxide does not interfere with or prevent absorption of the iron preparation from the gastrointestinal tract as evidenced by the rise in reticulocyte counts and hemoglobin levels.

3. In spite of persistent chronic bleeding of mild character, it is possible to maintain a constant red blood count and hemoglobin level.

The authors wish to express their appreciation for the valuable assistance rendered by Dr. Robert C. Batterman.

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SECONDARY OPERATIONS ON THE BILIARY TRACT

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THE necessity for performing secondary operations on the biliary tract is directly related to the type of pathology present at the first operation and to the ability of the first operator to manage this pathology. The frequency of secondary biliary surgery, therefore, will vary tremendously in different localities. In our own experience from January 1, 1935, to January 1, 1940, thirty-three of 231 cases of biliary tract surgery came to us because a second operation was necessary. This is an incidence of secondary operations of 13 per cent which, no doubt, would be lower in a larger group of cases. It is well known, however, that later surgery after operations on the biliary system is by no means rare. Since these secondary operations are frequently very complicated and dangerous procedures, we wish to make certain suggestions for the reduction of their frequency and to discuss the methods we have found valuable in their management.

The commonest indication for a secondary operation on the biliary tract is the recurrence of trouble in a gallbladder that has been previously drained. Thus, sixteen of our thirty-three patients, or more than half, had trouble either in the gallbladder, the common duct, or both following a previous drainage of the gallbladder.

There is no doubt that drainage rather than removal of the gallbladder at the first operation is occasionally indicated. We are convinced that the necessity for this procedure, however, constantly decreases as one's experience in gallbladder surgery increases and as one treats the acute cases at an earlier stage of the disease. We still drain in patients having serious infection in and about the wall of the gallbladder as a result of an acute obstructive cholecystitis that has not quieted down. If one adopts the policy of immediate surgery in acute cholecystitis,[1,2] the necessity for these difficult secondary operations in previously drained acute gallbladder cases will be far less.

We occasionally (once in recent years) have drained the gallbladder because of technical difficulties. These difficulties are usually due to poor anesthesia that prevents adequate exposure, or extreme obesity, or both. With adequate anesthesia such cases will rarely be seen.

In the past, before vitamin K and bile salts helped so materially, our preliminary treatment was occasionally to drain both the gallbladder and common duct in patients with severe obstructive jaundice. Today this should be rarely, if ever, necessary.

We have believed in the past that in certain elderly people who were poor risks for surgery that gallbladder drainage and the removal of gallstones was safer than cholecystectomy. This we are coming to question, however, after having certain of these patients return, when some years older, with recurrent stones in the gallbladder or bile ducts. We are inclined today to be a little more radical at the first operation and by a primary cholecystectomy avoid the risk of later trouble in elderly patients.

A persistent sinus following gallbladder drainage is by no means a rare reason for further biliary surgery since it was present in seven of our cases. In six of the seven patients the sinus led to the gallbladder in which stones were found at the second operation. In the seventh case the sinus was found to lead down to a large gauze pack which lay in the gallbladder fossa of the liver. Ten days after this foreign body was removed it was necessary to reoperate

upon this patient a third time and remove two stones from the common duct. Recovery from this point on was excellent. It is obvious that in six of these cases, a primary cholecystectomy, had it been safe, would have avoided months and years of draining sinuses, repeated abscess formation and biliary colic. One cannot but wonder from these cases if there is not a recent tendency to drain the gallbladder on too little provocation.

Fig. 1.

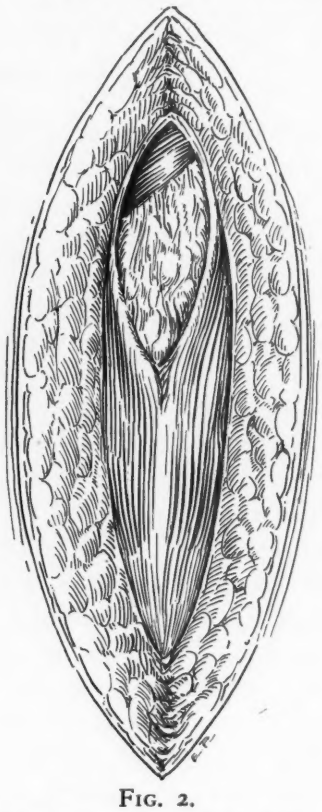

Fig. 2.

Fig. 1 Scar of the previous cholecystectomy is excised. This gives better healing surfaces and avoids the unsightliness of multiple scars.

Fig. 2. The incision is carried down through the fat and the fascia and the rectus muscle. At the upper end of the incision the peritoneal cavity is entered by going through the transversalis fascia and peritoneum. The liver is encountered first and the omentum adherent to its undersurface in the gallbladder bed.

Stones in the common duct after previous cholecystectomy are a very definite and quite common reason for secondary operations. In twenty-five of these thirty-three cases the common duct was explored. Stones were found and removed from the duct in ten of these. The frequency of common duct exploration at the time of cholecystectomy is generally high today, and this no doubt has reduced the frequency of overlooked common duct stones. All of us, however, may leave common duct stones behind us. Thus we explored the common duct in eighty-eight (46 per cent) of 191 cholecystectomies for stones, yet we left a stone behind in two cases. In one we explored the duct at the first operation and in the other we did not. In one, a woman aged seventy-three, who had severe obstructive jaundice and hypertensive heart disease, we drained the gallbladder and removed innumerable stones from the gallbladder and common duct. There was much calcareous material in the common duct which was very hard to remove.

Apparently we left some behind, for she had a recurrent common duct stone for which we operated eight months later. In

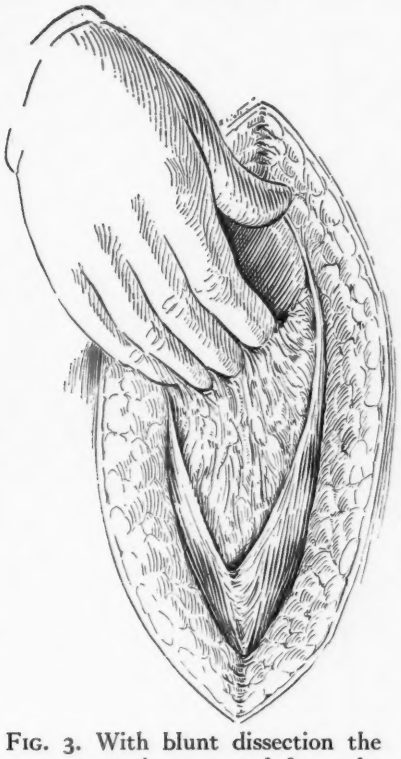

Fig. 3. With blunt dissection the omentum is separated from the undersurface of the liver. One must start with the liver as a landmark and work downward until one comes to the gastrohepatic omentum—the next important landmark.

the common duct should not be explored in every operation for gallstones if it can be safely done. The change in appearance of

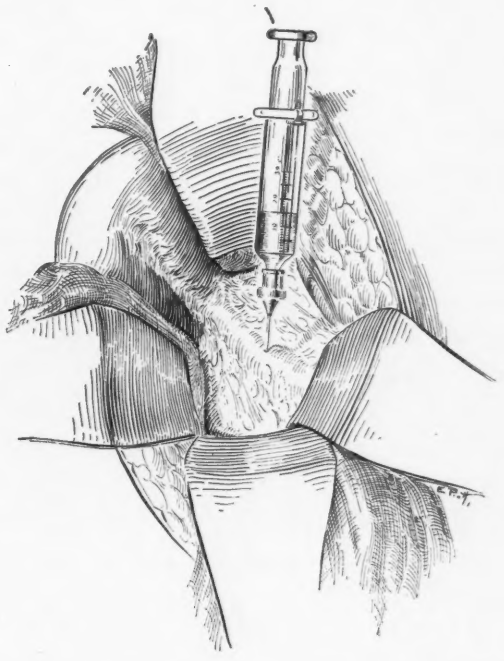

Fig. 4. When the gastrohepatic omentum is found, the outline of the common duct can usually be seen. The duodenum is now retracted downward and mesially. A syringe and fine needle are used to tap the suspected area. When bile is obtained, the location of the common duct is confirmed.

our second case there is perhaps less excuse for overlooking a common duct stone. The patient was a woman of sixty-four who had angina pectoris and had had a coronary infarct some years before. She was a chronic invalid. Weeks were spent in study and discussions with cardiologists and medical men regarding the safety and the desirability of attempting the removal of her gallstones. Operation was finally undertaken and a simple cholecystectomy rapidly performed. The common duct looked and felt normal and was not opened. Five months later we reoperated upon her and removed a single common duct stone from the common duct, nearly 2 cm. in diameter. She stood both operations well and has had much less of her angina-like pain. An experience such as this makes one wonder if her common duct also raises the query whether or not we pushed a stone from the gallbladder into the duct at the first operation. It may well be that the adoption of *x*-ray studies of the common duct at the time of operation (choledochograms) is the only way we can avoid leaving an occasional stone in the common bile duct.

Secondary operations on the biliary tract are occasionally necessary for the correction of strictures of the common bile duct caused by operative injuries of the duct. Injury of the common bile duct at operation may occur during hurried attempts to catch a bleeding cystic artery. Unless great care is taken the clamp may catch the wall of the common duct as well as the vessel and traumatize it so that a stricture results. Strictures of the common duct may

follow when the operator either clamps, ligates or even removes part of the common duct. In this group of four strictures, all previous attempts at repair of the stricture, this is a very difficult procedure. However, it is the best way, we believe, to manage

FIG. 5. Common duct is opened and instruments are inserted to remove stone or débris. In the insert is seen the T-tube cut so that it can be later removed without too great damage to the opening in the duct.

operated upon elsewhere, one was caused by clamping the common duct while controlling a hemorrhage; two followed ligation of part of the common duct, and one followed the actual removal of part of the common duct that was mistaken for the cystic duct. It is obvious that with good anesthesia and proper exposure the last three cases would not and the first one should not have occurred.

We were able to remove the ligature about the common duct in one of these patients seven days after it was tied. With long drainage by means of a T-tube a good result ensued. In the other three cases we anastomosed the common hepatic duct to the duodenum. In all these patients, some of whom have had two, three or even more strictures in the common hepatic duct. One of our patients died from a leaky suture line and the remaining three made good recoveries with relief of their jaundice.

Strictures due to injury of the common duct can certainly be prevented. No one should attempt to clamp the cystic artery or cystic duct unless he clearly visualizes the common hepatic duct and the common bile duct. Unless such visualization is obtained it is far better to drain rather than remove the gallbladder. There is, in our experience, no more serious complication of gallbladder surgery than an injury to the major bile ducts.

There is remaining a small group of puzzling cases in which secondary operations are occasionally necessary. These

patients have typical attacks of biliary colic with occasional fleeting jaundice after their first operation, yet at secondary operation no stone or stricture is found. Their gallbladders are generally thickened and show a chronic cholecystitis. Their common ducts are usually somewhat larger than normal. Probing of the sphincter of Oddi frequently shows it to be unusually tight.

Although one finishes an operation in these circumstances with some misgivings, the late results have been good in 75 per cent of our cases. In these cases we believe the gallbladder should be removed, the common duct explored and the sphincter of Oddi dilated, even though one feels no stones.

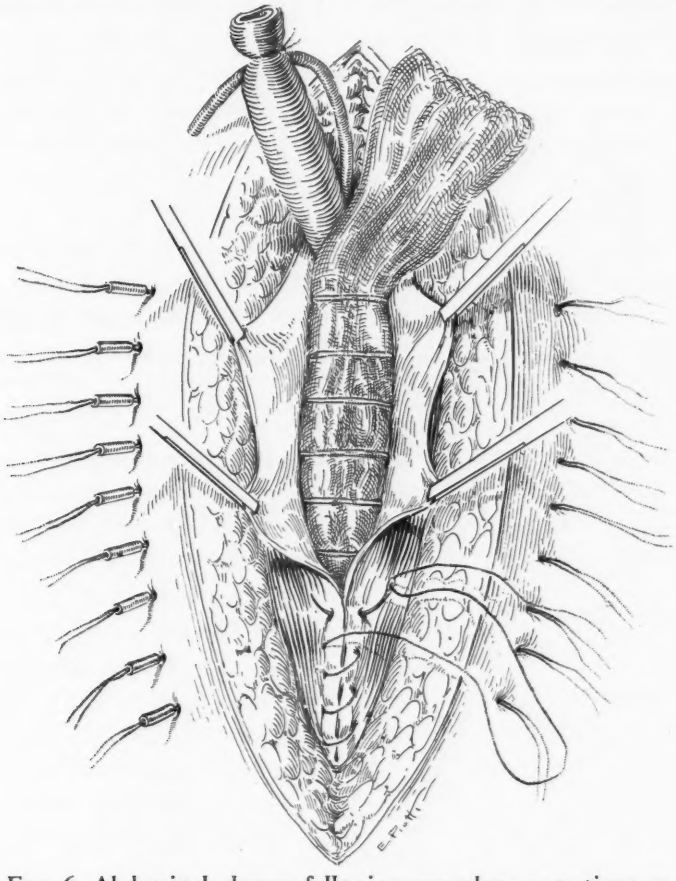

Fig. 6. Abdominal closure following secondary operations on the biliary tract with through-and-through sutures through all layers spaced no more than 1.5 cm. apart. Note the separate continuous catgut sutures for the peritoneum and transversalis. This is followed by another suture for the rectus fascia. All cases are drained with a cigarette drain to Morrison's pouch whether a T-tube has been inserted into the common duct or not.

TECHNIC

In order to carry out any secondary operation on the gallbladder or the major bile ducts it is essential that a large and complete exposure of these structures be obtained. It is our intention here to discuss only the methods we use to obtain this exposure. Details of the actual procedures once the exposure of the field is at hand are too well known to require repetition.

The scar in the skin and fat of the previous incision is excised down to the rectus fascia. (Fig. 1.) This gives better skin surfaces for later suture and leaves but a single scar. The rectus fascia and shreds of rectus muscle are now divided (Fig. 2) for the length of the wound. The wound should be long, extending from the costal margin well

below the umbilicus. At the upper end of the incision a nick is made through the transversalis muscle, fascia and peritoneum. The border or part of the right lobe of the liver with omentum adherent to its under surface is now seen.

With the fingers, the omentum is separated from the inner surface of the peritoneal layer and the incision through the peritoneum is carried down the length of the entire wound.

Exposure of the gastrohepatic omentum is now started by gently freeing the adherent omentum from the gallbladder or its fossa in the liver. (Fig. 3.)

One must keep this gentle finger dissection right against the liver tissue and avoid breaking into liver substance. A wet pack held by a Deaver retractor, as the dissection proceeds, controls any ooze and aids exposure.

With another wet pack and a large Deaver retractor the upper border of the duodenum is pulled inward and downward. (Fig. 4.) This places the gastrohepatic omentum under tension and permits the final freeing of adherent structures from the gallbladder bed. Occasionally the duodenum or pylorus are densely stuck into the gallbladder bed and must be removed by sharp dissection. It is better to take off a bit of scar tissue or even liver tissue than to make a hole in the duodenum. If, however, one tears a small hole in the duodenum it can be sutured at once. We have had no complications from this injury.

When the edge of the gastrohepatic omentum is visible, one can usually see the line of the common duct. If need be, a little blunt dissection with small gauze pledgets on a snap will bring it out. If any uncertainty exists, one may plunge a tiny hypodermic needle into the area and attempt to withdraw bile into the syringe. (Fig. 4.)

The location of the common duct being assured one can now make more of its extent clearly visible with careful dissection. The duct is now ready to be opened (Fig. 5), and such procedures as may be indicated can be carried out.

We take great pains and considerable time in closing the wounds after secondary operations on the biliary tract. (Fig. 6.) Rubber-guarded sutures of double silkworm gut are placed through all the layers of the abdominal wall. The peritoneum and transversalis are closed in one layer and the rectus fascia in a second layer. Finally, the through-and-through sutures are lightly tied so that they will not cause pressure necrosis. Drainage to the operative site is used in all cases.

CONCLUSIONS

1. The necessity for secondary operations on the biliary tract varies with the type of pathology present at the first operation and with the ability of the first operator.

2. Thirteen per cent of the biliary tract cases coming to our clinic came for secondary operations. This, we believe, is too high an incidence.

3. Over one-half of our secondary operations were on gallbladders previously drained. It is doubtful if so many cases should today have cholecystostomy.

4. In nearly one-third of the cases stones were present in the common duct. We have not yet reached a sure method for finding and removing all common duct stones at the first operation.

5. In four cases strictures of the common duct followed injury at the first operation and in one other case a gauze pack and common duct stones were found. There is slight excuse for complications of this type in modern gallbladder surgery.

6. A description of the writer's technic for exposing the common duct in secondary operations is given.

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AMNIOTIC FLUID (AMFETIN) IN ITS RELATION TO INFLAMMATION

OBSERVATIONS IN THE RABBIT AND IN MAN*

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AMNIOTIC fluid, most often bovine, has been found to be a satisfactory agent in influencing favorably peritonitis and the inhibition of abdominal adhesions. Johnson's[1] original observations in 1927 showed that bovine amniotic fluid was harmless. It possesses a complement fixation reaction equivalent to that of spinal fluid or one-eighth of that contained in normal pig serum. The fluid when injected intradermally into Dr. Shields Warren and also into Drs. Warren and Herbert Johnson produced a slight reaction at the end of twenty-four hours. At the end of forty-eight hours the reaction had largely disappeared and at the end of ninety-six hours there was no visible reaction.

The mechanism by which the effects of amniotic fluid are produced has been discussed by Johnson,[2] Warren,[3] Shimberg[4] and Gepfert and Stone.[5] In addition to the local action of amniotic fluid it has been found that patients receiving it intraperitoneally have a definite decrease in the amount of nausea, vomiting, distention and gas pains. The fluid has no effect on blood pressure, pulse, temperature or number of wound infections.[5,6] Recently, amniotic fluid has been used in the treatment of certain orthopedic conditions with satisfactory results.[4]

Bovine amniotic fluid is selected as one of the agents for study in our series of experiments on the factors that influence permeability and inflammation in the rabbit.[7–10] This study includes our observations on the effect of amfetin, first, on capillary permeability in the skin of the rabbit, second, the skin reactions in man, and third, the effect of amfetin on the number of leucocytes in the circulating blood of the rabbit.

METHODS AND MATERIALS

The amniotic fluid† (amfetin) is obtained from the cow and is filtered through a Berkefeld instrument and concentrated. It contains methiolate, 1:20,000 as a preservative.

Frequent injections, either intravenously or intraperitoneally, are made over a period of approximately a month into a group of rabbits before 0.2 cc. of the amfetin is injected intradermally in the studies on the skin reactions and capillary permeability. All rabbits are shaven twenty-four hours or longer before the skin tests are made. The time at which the intradermal injections of amfetin is made before 10 cc. of a 0.2 per cent solution of trypan blue is given intravenously is recorded in the individual experiments. The skin is observed for an hour following the injection of the dye to determine the site of the localization of the trypan blue. Areas of skin are removed following the intradermal injection of amfetin and fixed in a solution of 10 per cent formalin. Paraffin sections are prepared and stained with hematoxylin and eosin.

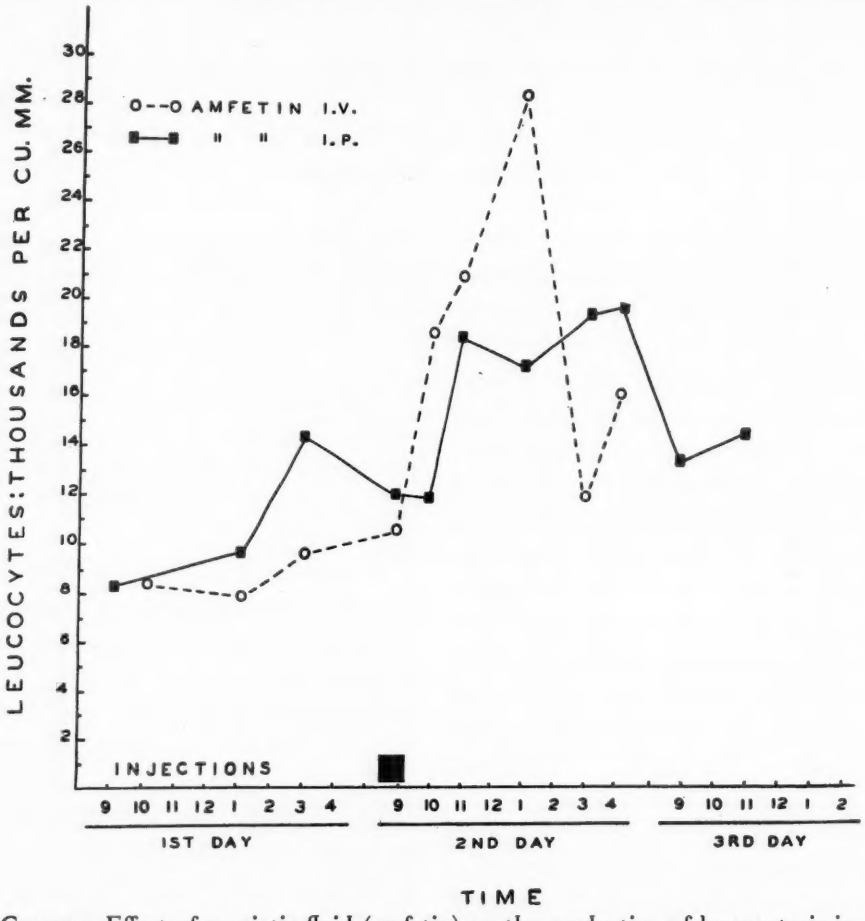
Horse serum‡ is used as a control for the amfetin in some of the experiments. Standard laboratory procedures are used in the precipitin reactions. The serum is obtained by bleeding from the heart.

† Supplied through the courtesy of Eli Lilly and Company.

‡ Supplied by Lederle Laboratories.

* From the Department of Pathology, University of Tennessee, Memphis, Tennessee. Aided by grants from the John and Mary R. Markle Foundation and the University of Tennessee.

A group of forty patients in the John Gaston Hospital were used in a study of the skin reactions to amfetin. Intradermal injections of 0.1 cc. of amfetin were made into the flexor surface of the left arm and a similar amount of horse serum was injected into the right arm. Observations were recorded after thirty minutes, one hour and twenty-four hours.



Graph 1. Effect of amniotic fluid (amfetin) on the production of leucocytosis in the rabbit.

The white blood cells in the peripheral blood are counted in one group of rabbits given amfetin intraperitoneally and in a second given amfetin intravenously. Blood is obtained from the ear.

EXPERIMENTAL OBSERVATIONS ON CAPILLARY PERMEABILITY IN THE SKIN OF THE RABBIT

In previous studies on capillary permeability and inflammation, it has been shown that trypan blue following an intravenous injection localizes and concentrates in areas of inflammation only during a specific interval.[7] The localization and the concentration of this dye is not determined by either the presence or the absence of edema, hyperemia or the local accumulation of polymorphonuclear leucocytes. It has been suggested that trypan blue localizes and concentrates in tissue as a result of a temporary change that occurs within the epithelial cells, the connective tissue cells and the endothelial cells of the capillaries.[9] Irritants, such as xylol, staphylococci and staphylococcus toxin have been either injected intradermally or applied locally in the study of capillary permeability.[7–11] Capillary permeability has also been studied in the skin of rabbits sensitized to horse serum.[10]

In this experiment, four rabbits were injected in tradermally with 0.2 cc. of

amfetin at the following intervals before 10 cc. of trypan blue was given intravenously, five hours, three hours, one hour, thirty minutes, fifteen minutes and immediately. Trypan blue localizes and concentrates in only the last four areas where the amfetin is injected. These observations were made usually in duplicate.

Five rabbits were given 3.0 cc. of amfetin intraperitoneally at each of four injections, given at five day intervals, before 0.2 cc. of amfetin was injected intradermally. The intradermal injections were made at the following intervals before 10 cc. of a 0.2 per cent solution of trypan blue was given intravenously. Two rabbits were used for the controls. Trypan blue localizes and concentrates in the intradermal areas injected with amfetin in the rabbits given the series of intraperitoneal injections essentially the same as in the controls. The dye localizes and concentrates only in those areas injected with the amfetin one hour or less before the dye is given. The portions of skin injected with the amfetin show a larger area of the dye in the rabbits given the intraperitoneal injections of amfetin than in the normal animals.

The above observations suggest that the skin of the rabbit does not become readily sensitized to amfetin.

To study further the reaction of the rabbit to amfetin four animals were injected with both amfetin and horse serum as follows:

Date	Amfetin	Horse Serum
August 26	1.0 cc. I.V.	1.0 cc. I.V.
August 31	5.0 cc. I.P.	5.0 cc. I.P.
September 6	5.0 cc. I.P.	5.0 cc. I.P.
September 7	1.0 cc. I.P.	1.0 cc. I.P.
September 8	1.0 cc. I.P.	1.0 cc. I.P.
September 10	1.0 cc. I.P.	1.0 cc. I.P.
September 11	1.0 cc. I.P.	1.0 cc. I.P.
September 12	1.0 cc. I.P.	1.0 cc. I.P.
September 13	1.0 cc. I.P.	1.0 cc. I.P.
September 18	Blood obtained from heart for precipitin reaction.	
September 25	Skin test made with amfetin and horse serum.	

The precipitin reaction after sixty minutes was as follows:

Rabbit	Amfetin	Horse Serum
10	0	1-1280
11	0	1-1280
12	0	1-20
13	0	1-80

The above four rabbits were injected intradermally with 0.2 cc. of amfetin on the left side of the abdomen and with 0.2 cc. of horse serum on the right side at the following intervals before 10 cc. of trypan blue was given intravenously; twenty-four hours, six hours, four hours, one hour, thirty minutes, and immediately. The dye localizes and concentrates in the areas injected with horse serum and amfetin as long as one hour before the dye is given. Large areas of edema and hyperemia occur when the horse serum is injected four, six and twenty-four hours previous to the injections of the dye. Essentially no edema or hyperemia occur in any of the areas where the amfetin is injected.

Polymorphonuclear leucocytes were present in the subcutaneous tissues two hours following the intradermal injection of 0.2 cc. of amfetin. There was an increase in the number of these cells for approximately six hours. It is of interest to observe that trypan blue following an intravenous injection fails to concentrate in the amfetin injected areas of skin when the dye is given longer than an hour after the amfetin. The absence of any relationship between the time that trypan blue concentrates in an area and the presence or absence of polymorphonuclear leucocytes has been observed and discussed elsewhere.[7–9]

SKIN REACTIONS IN MAN FOLLOWING THE INTRADERMAL INJECTION OF AMFETIN

In 1927, Johnson[1] found that three men showed only a very faint reaction after twenty-four hours to the intradermal injection of amniotic fluid. After forty-eight

hours, the reaction had subsided. In the present experiment, a study of the skin reactions in forty hospital patients is reported. Only two of these patients showed a reaction to the intradermal injection of amfetin. One developed an area of erythemia 2.0 cm. in diameter after thirty minutes. This disappeared within an hour. A second patient showed a similar reaction one hour following the injection of the amfetin. This erythemia completely disappeared within a period of twenty-four hours. Eight of the same patients given horse serum intradermally showed erythemia after thirty minutes. Many of the latter reactions persisted for more than an hour and one remained for twenty-four hours. The results of this group of skin tests indicate that man does not develop spontaneously any sensitivity to bovine amniotic fluid.

EFFECT OF AMFETIN ON THE WHITE BLOOD CELL COUNT IN THE RABBIT

The normal white blood cell count was established for each rabbit at four different intervals. Twelve rabbits were given 10 cc. of amfetin intraperitoneally. Graph 1 shows the number of white blood cells before and after the injection of the amfetin. No pathological changes were observed in the cells in the peritoneal fluid. It is obvious from Graph 1 that the white blood cells increase in the peripheral blood within two hours following intraperitoneal injection of amfetin. The number of white blood cells return to normal within twenty-four hours following the injection of amfetin.

In the second part of this experiment the white blood cells from four rabbits were counted at four different intervals before 10 cc. of amfetin was injected intravenously. The results of this experiment are also shown in Graph 1. There was an immediate rise and a progressive increase in the number of leucocytes for four hours following the injection of amfetin intravenously. Six hours following the injection of the amfetin the number of leucocytes were again within the range of normal.

DISCUSSION

The observations made in this study indicate that amfetin is harmless when given intraperitoneally and intravenously to rabbits in quantities as large as 10 cc. Rabbits fail to develop a precipitin reaction following a series of injections of amfetin. There is essentially no difference in the degree of edema and hyperemia following the intradermal injection of amfetin in animals previously injected with amfetin and normal rabbits. The absence of precipitins in the serum and the absence of a hypersensitive reaction in the skin indicate that amfetin as used in this experiment is either a very poor antigen or the rabbit is an unsatisfactory animal for such an experiment. Studies are now being made on the antigenicity of amniotic fluid.

The absence of any reaction in forty patients following the intradermal injection of amfetin except for the two reactions that quickly disappeared would indicate that humans are not normally sensitive to bovine amniotic fluid. It is important to know whether or not amfetin is antigenic in man since some patients may be given this fluid on two or more occasions. There appears to be only a few observations, as far as we have been able to determine, on the immunological reactions to amniotic fluid.

From our present knowledge and from a review of the results reported in the literature, amfetin is a satisfactory substance to use in serous cavities. The results show that first, amfetin diminishes nausea, vomiting, distention and gas pains. It has no effect on blood pressure, pulse, temperature or number of wound infections.[5,6] Second, the mortality rate is less in dogs subjected to peritoneal trauma and infected with staphylococci, streptococci and Bacillus coli when amfetin is placed in the abdominal cavity than in the controls.[6] Third, the presence of many polymorphonuclear leucocytes in the abdominal cavity appears to be a satisfactory method to combat bacteria. Fleisher and Rich[12] have recently

shown that the number of circulating leucocytes may be correlated with recovery in guinea pigs inoculated with pneumococci. The present study shows that the number of leucocytes increase in the peripheral blood of the rabbit when amfetin is given both intraperitoneally and intravenously. Johnson has already shown similar changes when amfetin is injected intraperitoneally in the dog.[13]

The fact that amfetin when given intravenously produces a marked leucocytosis in the rabbit is important in any study on the mechanism of leucocytes. Menkin[14,15] found that "there is present in exudates a leukocytosis—promoting factor capable of inducing a rise in the leucocytic level of dogs." Observations[14,15] also show that rabbits react similarly to the leucocytosis-promoting factor in exudates. It is, therefore, very important in any study of inflammation to know that amfetin contains a leukocytosis-promoting factor. The type of leucocytic response to amfetin in the rabbit is apparently the same as that occurring in dogs following the intravenous injection of exudates.[15] It will be important to determine the relationship between the leucocytosis-promoting factor in amfetin and that which occurs in inflammatory exudates.

It appears to be conclusive from the studies of both Menkin[14] and Rigdon[9] that the changes responsible for the localization and concentration of trypan blue are different from those by which leucocytes localize in an area of inflammation. The present experiments show that the time during which trypan blue localizes and concentrates in areas of skin injected with amfetin following an intravenous injection is the time in which the fewest leucocytes are present in the tissue.

SUMMARY

Amfetin appears to be a satisfactory substance for concentrating leucocytes in a serous cavity. The presence of an increased number of leucocytes in a serous cavity and in the peripheral blood appears to be advantageous in the presence of certain bacterial infections.

Amfetin apparently is an important preparation for the study of certain immunological reactions and also for the study of the mechanism of leucocytosis.

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THE SYMPTOMS AND SIGNS OF METASTATIC CANCER

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IT is not generally realized that cancer often makes itself known first by giving rise to symptoms or to a sign from a metastasis which may be at some distance from the primary growth. It is well known, of course, that a cancer (of the stomach for example) may reach a large size without causing symptoms of any marked degree. However, we have seen enough cases of unusual symptoms or signs apparently unassociated with carcinoma, that it may be of value to record a few instances and to discuss symptomatology of metastatic carcinoma in general.

Naturally, when a patient is within the cancer age one should always keep neoplasia in the back of one's mind, but the mere fact that the individual is young does not by any means preclude cancer. For example, I saw a young man, aged twenty, whose only complaint was in reference to a lump which he had over the manubrium sterni. This had been present for nine weeks, was about the size of an olive and was painless. He had absolutely no systemic symptoms, but had lost four pounds in weight in the past two months. Upon biopsy of the tumor, we found typical adenocarcinoma which had originated we believed, in the stomach. Upon roentgenographic examination a large infiltrating tumor was found on the greater curvature which was considered inoperable.

A man, aged fifty-four, came to see us complaining of proptosis of the left eyeball, which had come on within a period of four months. He had been to see an optician who fitted him with glasses three months previously and told him that he had "astigmatism." When we saw him, he was given his first physical examination, and a hard irregular prostate was found, which had given him no symptoms whatever. We made a diagnosis of metastasis to the orbital plate of the frontal bone from a cancer of the prostate, which was corroborated by *x*-ray examination.

A man, aged sixty-four, went to a chiropractor to be treated for pain in his neck which was mild, and which had been troubling him for a few days. The "chiroquacktor" gave him an "adjustment" (so-called), something snapped, and the man had severe pain in his neck with complete immobility. When we saw him, roentgenographic studies showed metastatic carcinoma, which, upon physical examination, was proved to have originated in the prostate gland.

This next case is most unusual, and in spite of all our efforts, the diagnosis was not made until a metastatic lesion made itself evident. The patient was a man, aged thirty-nine, who came to us complaining of symptoms which pointed to possible brain tumor. There were character changes, irritability, occasional twitchings of the right arm, but upon examination the optic fundi were negative, as was every other study that was done. We did not *x*-ray this patient's pelvis because there was no reason at all why we should, as far as we could see. After an exhaustive study, and following ten days in the hospital and in bed, one of the nurses, while assisting him to move around in bed, pulled upon his arm. A slight "give" was felt in the radius, and *x*-ray showed metastatic carcinoma. Although his prostate was considered to be only "firm," an *x*-ray of his pelvis showed the typical snow-flake appearance of advanced metastasis from a cancer of the prostate gland. Later, we learned that at autopsy, a brain tumor was found, which was metastatic.

I once assisted in operating upon a man for a brain tumor who was found to have a metastatic lesion in the frontal lobe. This growth was an adenocarcinoma, and upon re-examining this patient's rectum, we found, at 8 cm. within the rectum a small carcinoma which was hard and fixed. Upon his previous physical examination it had been missed. Claude F. Dixon[1] has pointed out that these hard small cicatrizing tumors of the colon and rectum are more prone to metastasize early than are the fungating cauliflower types. The patient had no symptoms whatever from the rectal growth, although he had definite symptoms of brain tumor, which, of course, he had.

I remember very distinctly the case of a young girl, aged twenty-four, upon whom we operated for what was very obviously an ovarian tumor of some kind. At operation, it was found that she did have an ovarian tumor, two in fact, one in each ovary, one the size of a grapefruit and the other as large as a golf ball. Simple oophorectomy was done, and during the procedure the pathologist reported adenocarcinoma of gastric type. Upon examining the stomach, which had up till now been completely forgotten, an early colloid carcinoma was found in the antrum, which had not given rise to any symptoms. Walters and I[2] found, in a series of ninety-six cases of cancer of the stomach in young people under the age of thirty, that Krukenberg tumors of the ovary were present in six of the thirty-six females, or in the ratio of 1:6. This does not mean that we must *x*-ray the stomachs of all patients with ovarian tumors, but it does suggest that when we are dealing with younger women with ovarian tumors we must always keep malignant disease of the stomach in the back of our minds.

A short time ago I saw a lady, aged fifty-eight, whose only complaint was "bronchitis" and "wheezing" of about three months' duration. She also became breathless upon climbing stairs, which was new with her. Upon physical examination we found a small hard lump in the lower neck just above and to the right of the sternal notch, which was painless, and which had not been noticed by the patient herself. *X*-ray showed advanced metastasis scattered throughout the entire lungs. Further examination showed the presence of a nonobstructing carcinoma of the transverse colon. The neoplastic cells had undoubtedly spread to the retrogastric lymph-nodes and from there on up the mediastinum to the lungs and to "Virchow's node."

When a carcinoma is discovered through the symptoms and signs set up by a metastasis, it is of course usually too late to do very much good. On the other hand, much useless and sometimes harmful treatment can be avoided if a correct diagnosis is made in the first place. Even in advanced cancer it is now possible to alleviate the patient's distress sometimes almost entirely. Furthermore, there are certain types of metastases which will respond well to roentgen therapy, and there are other types such as thyroid and kidney tumor metastases which will occasionally become greatly slowed up by the removal of the primary growth.

We should bear in mind the possibility of pathologic fracture due to metastasis in every case of fracture in people over the age of forty, in whom the trauma causing the break has not been excessive. I have found that it is wise to consider every case of indefinite abdominal or other pain to be due to cancer or cancer metastasis no matter whether the patient is within the cancer age or not, until it has been proved otherwise. The younger the patient, the more apt are the symptoms to be unusual and bizarre. Three years ago a girl, aged sixteen, was brought to the hospital with a history of three days of vomiting, mental lassitude and weakness. Prior to the present attack she had never been sick in her life. She was admitted to the neurological service with a provisional diagnosis of brain tumor, one optic disc having been found to have a moderate degree of choke. Her condition became worse and she died in three

days. At autopsy, the most widespread and generalized metastasis that I have ever seen was found. Every organ in the body was involved in the process, which originated in the stomach. We must note that this girl never at any time had stomach symptoms until the last six days before she died. Naturally, even though the correct diagnosis had been made when she was brought in, the outcome would have been the same. However, I believe that it is instructive to us in that we must realize that occasionally we will be called to see patients having what appear to be acute attacks of appendicitis, gallbladder disease, etc., but who are really suffering from symptoms due to metastases from cancer which has been growing unrecognized. This last case is of course, as bad as they come.

The well known frequency with which melano-epithelioma and melanosarcoma metastasize recalls a striking case. A patient, a man aged thirty-four, came to us complaining of a brownish coloration of his entire skin which had been coming on for five months. His skin had the appearance which is found in a fairly advanced Addison's disease, which diagnosis I made. My chief, however, asked him what a two-inch scar was for, which he discovered just over the right scapula. The patient replied that he had been operated upon five months previously for removal of a pigmented mole in that region. The diagnosis turned out to be melanosis from a generalized melano-epitheliomatosis of the entire body. The patient lived only a few months and was found to have melanomas throughout his entire body. This extraordinary case has been reported in full, and beautifully illustrated, by Odel, Montgomery, and Horton,[3] of the Mayo Clinic.

A surgeon, aged forty-four, complained of pain in his back of two months' duration, which had been getting more severe. Upon roentgenographic examination of the lower spine, typical metastatic infiltration was seen in the body of the third lumbar vertebra. Upon further physical examination a very slight spindle-like swelling of the right femur was found which proved upon *x*-ray to be a sarcoma. He received alcohol injection along Dogliotti's method on six occasions thereafter, which controlled his pain until his death from widespread dissemination. There is no doubt but that some of these patients have been treated with splints, braces, etc., when the true diagnosis has been missed.

These nine cases are examples of hundreds of similar histories which can be found in the files of physicians and hospitals all over the country. The patients who have metastatic lesions offer difficult diagnostic problems, as a rule, and I offer this last instance as an example of a diagnosis made almost by accident, after much previous investigation had failed to solve the problem.

The patient was a lady, aged fifty-two, who complained of a small lump well down in the neck, almost touching the manubrium, which was hard, and about the size of an olive, and which had been present for three months. It had been slowly increasing in size. Naturally, a metastasis from a cancer of the stomach was considered, but the roentgenographic study of that organ was entirely negative. The mouth, head, lungs, et al. were also negative for any pathological condition. After six days in the hospital, the chief and a half dozen interns were standing around the bed, when one of the interns asked for permission to use his new laryngoscope mirror which he had just bought. He did so, and upon reversing it so that he could look up into the posterior nares, a small adenocarcinoma was seen arising in that situation and producing no symptoms.

Unfortunately, the radio, with its continual blurb of patent medicines and nostrums of all kinds is of little help in bringing these patients in to see us early. The patient who has mild symptoms will often pay little attention to them, or will take some cure-all which has been touted by some glib-tongued announcer who rattles off a lot of high sounding pseudo-scientific palaver to impress the unsuspect-

ing listener. This is where, I believe,[4] it will be necessary for physicians and medical societies of national repute, to put in some good work. The blitzkrieg of the quacks is upon us as never before, and they are utilizing every facility at their hands, from radio to newspapers and handbills. It is true that many medical societies have organized speakers for radio time, but we, as a profession have just begun to fight. Most of us, unfortunately but only too truly, are too absorbed in our own field of work to give much time to what we think is a necessary but unavoidable evil.

CONCLUSIONS

1. We must remember that in every patient suffering from indefinite abdominal or other symptoms or signs there is always a slight possibility that the symptom may be due to the presence of an unrecognized cancer somewhere within that individual.

2. A complete and thorough physical examination (with especial reference to rectal and vaginal examinations) must be performed in all cases of indefinite abdominal or general symptoms.

3. Patients committed to mental institutions should have a careful and repeated eye-ground examination before and after admission to the hospital. Signs of a primary carcinomatous lesion must be looked for in every case.

4. *X*-ray of the chest should be done far more frequently than it is today, and upon far less indication. Even a negative chest report has positive value.

5. To prevent people who have vague indefinite symptoms from falling into the hands of the unskilled and pseudomedical charlatans it is the duty of the ethical medical profession today to use the radio and the newspapers as much as can be done within reason to fight organized quackery.

6. When studying *x*-ray plates no matter of what organ or bone, always think of metastasis from cancer.

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CLOSURE OF DIFFICULT ABDOMINAL INCISIONS

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MANY postoperative hernias are a result of faulty closure of the abdominal incision, particularly the peritoneum. Some postoperative hernias are unavoidable, occurring from prolonged drainage, poor musculature, low vitality of the tissues, possibly defective suture material and many other things which are beyond the control of the surgeon.

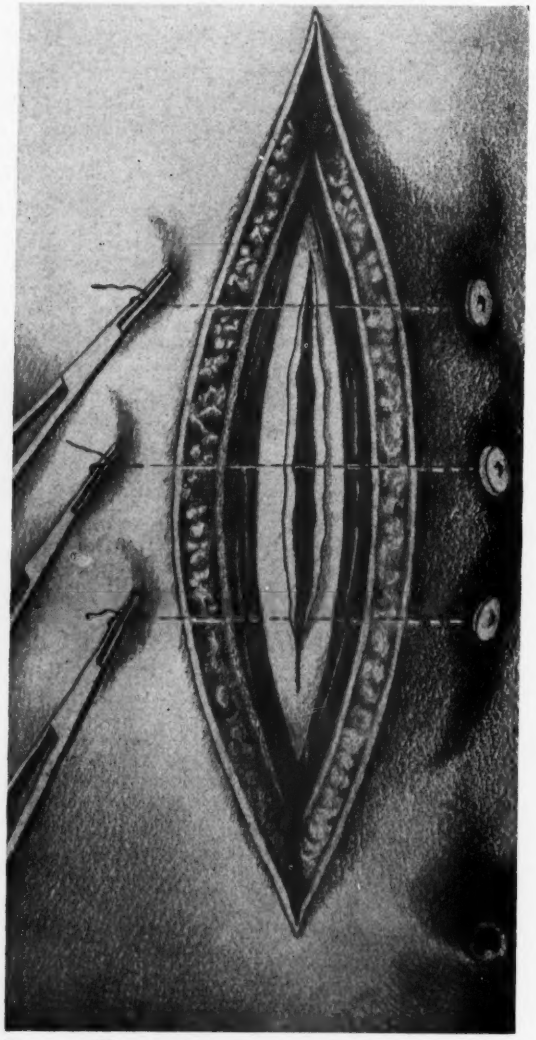

FIG. 1. Illustration showing the heavy tension sutures in place and drawn sufficiently taut to bring the edges of the peritoneum together with some eversion.

All abdominal incisions should be so planned that there will be ample room for the operation at hand, always having due respect for the muscles and their nerve and blood supply. In this planning, however, we must keep in mind that this incision must be closed with the least possibility of hernia following.

Very little difficulty is ever experienced in the closure of the fascia and muscle but this cannot be said of the peritoneal closure. Very often when we attempt to approximate the peritoneum we find the suture pulling out as we place it, leaving the edges frayed and torn with small gaps here and there along the suture line through which the omentum or intestine is likely to protrude and finally produce a hernia.

In closing the various incisions we find that the upper right rectus incision may give us more trouble than any other. Significantly, it is here that we have many, if not most, of our postoperative hernias. Drainage through this incision, which is so commonly done, is one of the factors which contribute to the formation of a hernia. However, good closure up to the drain, placing the drain as near the upper angle as possible, will greatly minimize the possibility of a hernia.

To overcome these difficulties in closure the following method will insure perfect approximation not only of the peritoneum but of the other layers as well. This method is especially applicable to upper right rectus incisions. However, it will be found useful in the closure of any abdominal incision in which there is likelihood of the peritoneum tearing when placing the suture.

A large button or forcep is firmly attached to the end of a double chromic No. 2 catgut or heavy silk, the other end being

threaded to a large cutting edge needle. Two or three such sutures are prepared depending upon the length of the incision. This suture is passed through all the abdominal layers, starting 4 cm. from the skin edge and emerging a like distance from the edge of the peritoneum. It is now carried through the opposite side of the incision in like manner. Forceps are attached to the peritoneum after which the tension sutures are drawn sufficiently taut to permit closure of the peritoneum without tension and danger of tearing. After all the abdominal layers have been closed the tension sutures are removed and discarded.

SUMMARY

Faulty closure of the abdominal incision accounts for many of the postoperative hernias.

There are certain incisions which are likely to be difficult to close. This is especially true of the upper right rectus incision—a frequent location for postoperative hernias. This difficulty is usually in the approximation of the peritoneum. However, we may have difficulty in closing the fascial layer.

A method is described which insures perfect approximation not only of the peritoneum but the other layers as well. The method is simple and merits its use in all upper right rectus incisions.

Case Reports

PENETRATING WOUND OF THE HEART WITH ELECTROCARDIOGRAPHIC TRACINGS

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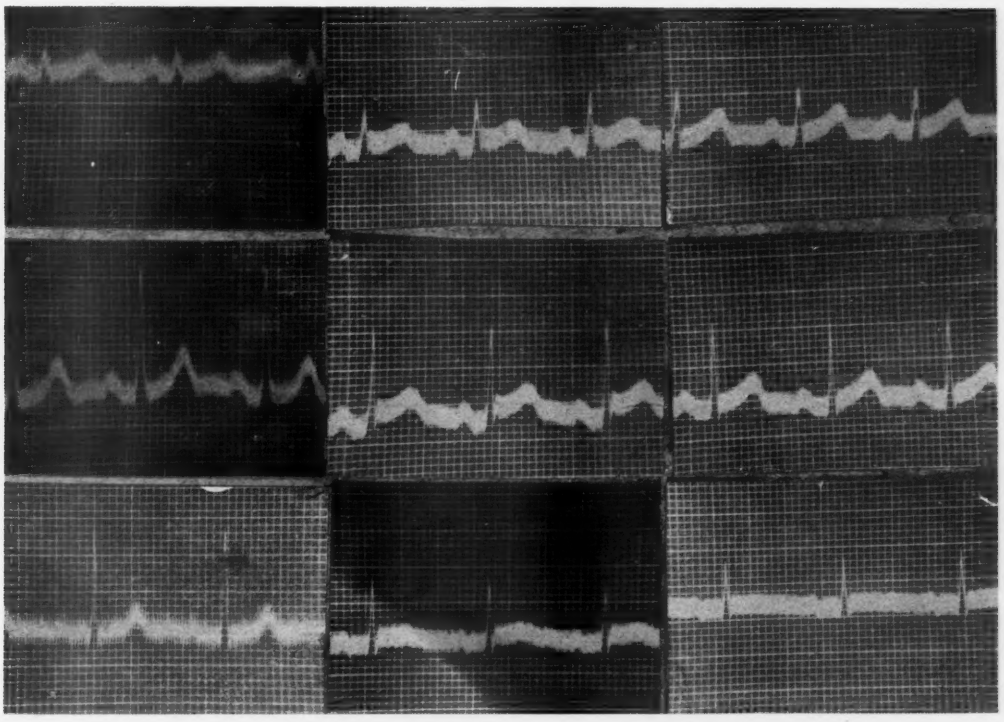
ALTHOUGH suture of penetrating wounds of the heart is a fairly common finding in the surgical literature, it is still a comparatively uncommon experience in the practice of most surgeons. Stab wounds of the heart are relatively frequent in sections of the country with large negro populations, and some surgeons have operated on more than twenty such patients.[1]

In mental institutions the injury is apt to be self-inflicted. It is, nevertheless, a rather unusual method of attempting suicide, even among patients who have an overwhelming urge to destroy themselves. The case report that follows concerns an individual who made two attempts to kill himself by stabbing himself in the heart, neither of which was successful—the first because of the location of the wound and the second because of prompt surgical intervention. The two attempts to injure the heart were made with the same type of implement. This tends to conform with Jameison's finding[2] that suicidal patients who survive the first attempt will generally continue to try the same or similar methods until they are successful.

CASE REPORT

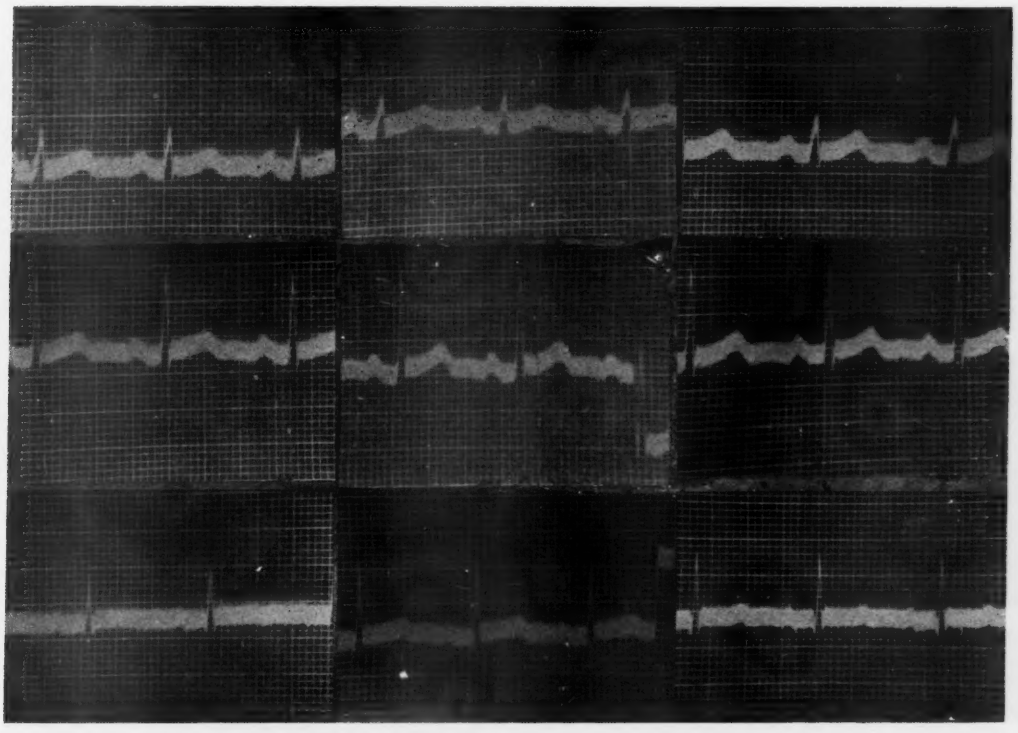
C. B., a white male, born on December 7, 1895, had been hospitalized several times since 1935 for the mixed type of dementia praecox. His mental condition was characterized by rather long lucid intervals punctuated by short acute psychotic episodes in which he was delusional and showed impulsive behavior. On February 23, 1936, he grabbed a metal pencil of the Eversharp type from another patient, jabbed it into the center of his chest at the lower end of the sternum and threw himself forwards on the floor. The pencil penetrated into the soft tissues of the anterior mediastinum, above the diaphragm and below the heart. The body of the pencil was readily removed, but the metallic lower end was deeply embedded and had to be removed under general anesthesia. The wound was packed and a rubber tissue drain inserted. The patient had a moderate febrile reaction for three days, his temperature going as high as 101°F. The drain was removed on the ninth postoperative day. There was nothing but a slight amount of serous drainage afterwards.

The second suicidal attempt was very similar to the first. On September 3, 1939, at 9:15 A.M. the patient carefully placed a pencil in the fifth intercostal space several cm. inside the midclavicular line, and threw himself on his face. At 9:30 A.M. he was seen by a physician (J. S.). The patient had picked himself up off the floor and removed the body of the pencil which he thrust into his left trouser pocket. He had lain down on his bed face downward. There was only a slight amount of external bleeding. The patient was unconscious,



A B C

FIG. 1. A, normal electrocardiogram three months before injury. B, third postoperative day. Elevation of RT segments in all leads, most marked in lead 2. C, tenth postoperative day. RT segments iso-electric except for slight persistent elevation in lead 2.



A B C

FIG. 2. A, twenty-third postoperative day. B, forty-second postoperative day. C, three months postoperatively.

cyanotic and his pulse was rapid and barely perceptible. Respirations were shallow. An *x*-ray of the chest was hurriedly made, and

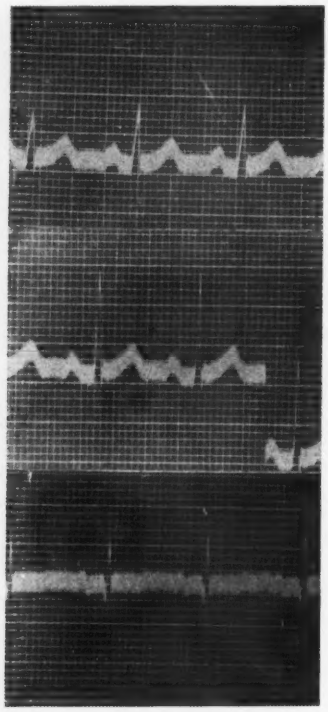
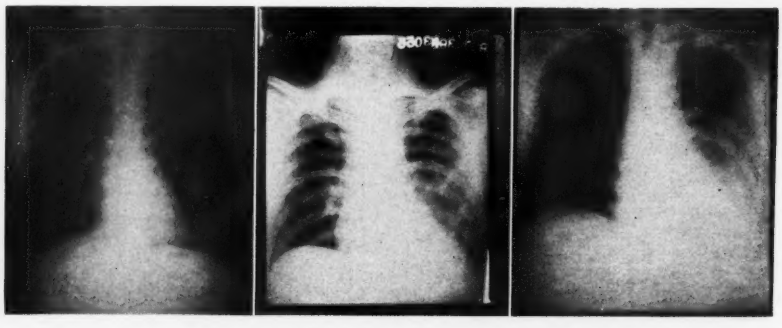


Fig. 3. Fourteen and one-half months after operation. Small Q wave in lead 3. T wave in lead 3 almost isoelectric.

it showed some widening of the cardiac shadow and also that the metallic end of the pencil lay in the left costophrenic sinus.

One cc. of adrenalin was given intravenously, and the patient's pulse and color improved rapidly, and consciousness returned for about five minutes, after which he again lapsed into a coma. The surgeon (R. L. M.) was summoned promptly, since the condition was recognized as a probable penetrating injury of the heart. Operation was started at 10:30 A.M. under minimal ether anesthesia.

A semicircular incision, about eight inches long, was made over the precordial region, with its convexity directed to the right and downward. Skin and soft tissues were cut through, and the cartilages of the fifth, sixth, seventh and eighth ribs severed about one inch lateral to the sternum. Sufficient portions of these ribs were removed to provide adequate exposure of the heart. The left lung was found to be completely collapsed. On inspection of the lateral surface of the pericardial sac, a slit about three-eighths of an inch long, was noted. Near the lateral margin and base of the left ventricle, there was a wound about 4 to 5 mm. in diameter, from which a stream of blood spurted with each systole of the heart. A purse-string suture through the pericardium and superficial layers of the myocardium was inserted. The end of the pencil was removed from the chest cavity, a large quantity of blood was mopped out and the chest wall closed in layers around a catheter. The chest cavity was then aspirated through the catheter, after which the catheter was withdrawn while still applying suction. A transfusion was given immediately after the operation. The temperature reached 103°F. on the first postoperative day and gradually subsided to normal by the end of the first week. Bed-side *x*-rays of the chest on the fourth and tenth postoperative



A B C

Fig. 4. A, normal chest three months before heart injury. B, fourth postoperative day, pericardial effusion, left-sided pleuritis. C, tenth postoperative day.

days showed complete re-expansion of the left lung, a moderate pericardial effusion and evidence of left-sided pleuritis. On the twentieth postoperative day there was considerable absorption of the pericardial fluid and a slight

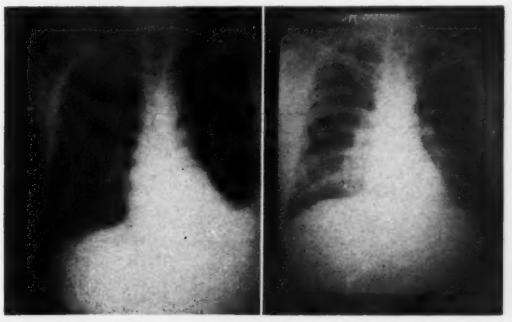
amount of fluid present on the left side of the chest. The patient's convalescence after that was essentially uneventful.

An electrocardiogram on the third postoperative day showed slight elevation of the RT segments in all leads, most marked in lead II, which type of picture has been described as characteristic of pericarditis.[3] On the tenth postoperative day the RT segments had returned to the iso-electric line, except for the one in lead II, which continued to maintain a barely perceptible elevation above the base line. Electrocardiograms taken twenty-three days, forty-two days and three months postoperatively did not show any T wave inversion. Other changes noted were diminution in amplitude of the QRS complexes in leads II and III, and a diphasic P wave in lead III. The absence of T wave inversion, which might be expected to occur with any localized area of myocardial damage, suggests that the area of muscle injury was quite small, or else that it was not in the plane of the conventional leads.

Mental improvement occurred following postoperative convalescence and he was allowed to leave the hospital several months later. The patient secured employment as an advertising executive and has adjusted satisfactorily to the present time. He was re-examined at an interval of more than fourteen and one-half months after the injury and was found to have a normal cardiac reserve and no symptoms referable to the cardiovascular system. A six-foot heart plate showed that the transverse diameter of the heart was the same as before the injury. The electrocardiogram was practically normal except for a small Q wave in lead III and an almost iso-electric T wave in the third lead.

SUMMARY

A patient is presented who was operated upon for a small penetrating wound of the left ventricle near the base of the lateral margin, complicated by a subsequent pericardial effusion and left-sided pleuritis with slight effusion. Serial electrocardiograms were made and are of interest because they showed elevation of the RT segments in all leads, most marked in lead II, as occurs in pericarditis. There was no subsequent T wave inversion, either because the area of myocardial injury was quite small or because it was not in the plane of the conventional leads. More than fourteen and one-half months after the operation the heart size was the same as before the operation, and the electrocardiogram was essentially normal except for a small Q wave and an almost iso-electric T wave in the third lead. There was no disturbance of cardiac function.



A B

FIG. 5. A, twentieth postoperative day. Absorption of pericardial effusion; slight pleural effusion at left base. B, normal chest fourteen and one-half months after injury.

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OSTEOCHONDRITIS DESSICANS OF THE LEFT ELBOW

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OSTEOCHONDRITIS dessicans as a clinical entity is not rare, especially in the knees. It is much less common in the hips, ankles and rare in the elbows, especially the left elbow. The first description of this condition was by Konig, in 1887. His description was as follows: "Without an injury, there separate from the joint ends fragments of varying size, in consequence of a process as yet unexplained, their bony surface becomes covered with a dense connective tissue containing cartilage cells here and there. In the same manner the defect in the bone becomes covered over. In some cases a smaller body composed entirely of bone, and smooth with the appearance of necrotic bone, lay under a larger piece perhaps 2 cm. in diameter. These pieces often fitted almost exactly in the corresponding bone defect seeming at times somewhat too large because the pits in the bone had become filled. Aside from this, together with a fluid effusion and slight villous hyperatrophy, these joints looked perfectly sound and they remained so after the removal of the loose bodies."

Konig did not give this condition a clinical name until 1905 when he called it "Osteochondritis Dessicans." Munro was the first to call the condition osteochondrosis dessicans. Osteochondritis dessicans was not described from the roentgenographic findings until it was described by Richards, in 1928. In 1925, Halinsh described the condition in the hip joint.

FIG. 1. Shows the *x*-ray films on the day of the injury.

Osteochondritis dessicans goes under many other names, such as osteochondrosis dessicans, bone necrosis, padgets necrosis, osteochondrolysis traumatic, malcopathica of the joints, and commonly called loosed bodies in the joint.

ETIOLOGY

There are many theories in regard to the etiology of this most interesting bone and joint change. I will only mention some of the theories without detailed discussion.

1. Trauma is considered the predominating cause. The trauma may be direct or

repeated trauma over a period of time, as a result of certain types of work. A direct cent occur in the knee joints, involving the lateral side of the medial condyle.

Fig. 2. Shows preoperative *x*-ray films on August 7, 1940.

trauma such as a direct blow, twist, jerk or jolt can cause the fragments to break loose.

2. The nontraumatic theory believes that there is a preexisting bone condition present, in which there is some softening of the end of the bone with fibrous changes.

3. Low grade infection in the bone which produces a softening of the bone.

4. Congenital bone predisposition, as the condition has been described involving several joints in the same individual.

5. Fat emboli as advocated by Rieger. He thinks that the fat embolii are the result of trauma and block off the blood vessels.

6. Gonatrophic in origin.

7. Disturbance in calcium metabolism.

Regardless of the exact etiology, all agree that tauma plays a very definite rôle, and trauma is held to be the principal etiological factor. It may be the result of one severe blow or repeated small traumas over a period of time in certain types of occupations. Munro states that definite trauma is the basic cause of osteochondritis dessicans. The condition can be a late result of injury. The condition usually occurs in otherwise healthy young individuals in the second, third and fourth decades of life. Some authors state that it occurs about equally in both sexes with predominance in males. Eighty-five per

CLINICAL SYMPTOMS AND FINDINGS

The clinical symptoms and findings are few early in osteochondritis dessicans. One of the earliest symptoms is that of pain, which is usually a dull ache and intermittent. Later, the pain becomes more severe and more steady in character. Following active use of the joint involved, the pain may be severe, caused by a chronic synovitis. This is particularly true in the knee and elbow. After the bone changes have taken place, the patient notices and complains of a grating noise on movement of the joint. Then a slight stiffening sets in, and this continues until the joint finally becomes ankylosed. There is definite pain on palpation and tenseness about the joint from the effusion into the joint. The musculature about the joint shows definite atrophy from nonuse, especially if the man is used to doing hard and heavy work. Lastly, the patient complains of a general weakness about the joint and instability or inability to hold or lift heavy objects. The diagnosis is finally made by the use of the *x*-ray.

MICROSCOPIC PICTURE

The microscopic picture shows the overlying cartilage normal, the subjacent bone necrotic, with loss of the lamellar structure. Foreign body giant cells are always present.

The picture is one of low grade necrosis with inflammatory reaction. The synovial fluid shows no change.

Fig. 3. Show *x*-ray films postoperatively, September 14, 1940.

TREATMENT

If the condition goes unrecognized for any period of time, a chronic synovitis develops, also a chronic traumatic arthritis as a result of the loose pieces of bone in the joint space. Conservative treatment after the diagnosis is made is of no avail. Surgical removal of the loose pieces of bone gives an excellent result with almost 100 per cent function in most cases. This is particularly true of the knee, ankle and elbow. One should always advise the patient that there is a possibility of their recurrence at some later date.

CASE REPORT

Mr. J. H. L., male, age thirty-one, married, a pipe fitter for an oil company, had had no serious illness nor any previous operations. The family history was essentially negative. There was no history of cancer, diabetes, insanity, etc. The patient denied veneral infection. He stated that he had always done hard and heavy work and that the work as a pipe fitter was unusually heavy.

On June 19, 1939, while working for an oil company he fell from a "polly tower" and hit or landed on the left elbow. There was a great deal of pain and he was taken to a doctor and *x*-ray films were made. (Fig. 1.) A diagnosis of fracture was made and a few days later he was asked to report to another physician who diagnosed the condition as a bad sprain and after ten days away from his work, he was advised he could return to his routine work. When he returned, from time to time he could hear a grating noise in the left elbow and called this to the attention of his foreman. He stated that this never existed before the fall. The grating and pain gradually became more severe and finally the left elbow began to lock, and by manipulation and having fellow workmen pull on the arm, he could unlock the elbow and keep on working. Finally, on August 2, 1940, the left elbow locked and he was unable to unlock the joint. He consulted the same doctors and was advised that there was nothing wrong with the elbow joint. After several days of suffering he was referred to me from the oil company for further treatment. On entering the office he was in great pain and was carrying the arm in a sling. After a complete history, I found he was unable to flex or extend the left elbow. There was no motion of supination or pronation. There was atrophy of the muscles above the elbow joint. On palpation there was a tenseness of the skin over the joint and severe pain. *X*-rays taken at this time showed four pieces of loose bone in the left elbow joint. (Fig. 2.) He was sent to the hospital and under cyclopropane anesthetic manipulation of the elbow was carried out. Some motion was obtained. The next day the elbow was locked again and operation was advised.

Preoperative X-ray Report, August 7, 1940. A roentgenological examination of films, anterior posterior lateral and oblique views, shows considerable fragmentation of the head of the radius. At least four bony fragments have separated from the articular margin of the head of the radius and are situated in the lateral half of the elbow joint. There is evidence of no callus in this area. The roentgen appearance is very suggestive of osteochondritis dessicans.

Under cyclopropane, ether and carbon dioxide an incision about four inches in length

was made over the outer part of the head of the left radius. The joint capsule was under tension and on opening into the joint a large amount of dark colored synovial fluid was seen, 50 cc. thicker than normal and having the appearance grossly of containing blood. Four pieces of bone were removed. The larger fragment was attached to the synovial membrane by a heavy fibrous adhesion. The entire joint space was covered with a substance gelatinous in character and it was curretted away. The head of the radius was of a light yellow straw color, and not the usual hard, pearly white appearance of normal bone.

The joint capsule was closed with interrupted sutures of chromic catgut No. 1, and without drains. The fascia was sutured with plain No. 0 interrupted sutures. The skin was closed with dermal lock stitch. Convalescence was uneventful and at the end of six weeks he was back at his routine work as a pipe fitter in the fields for an oil company. Also the only impairment of motion was a slight diminishing of extension of the forearm. (Fig. 3.)

X-rays taken on September 14, 1940, show complete removal of all the bony fragments noted on the previous examination within the elbow joint.

CONCLUSION

This case is presented for several reasons, first, because osteochondritis of the elbow is rare, especially the left elbow and I was able to find only two other cases involving the left elbow joint. I was able to find fourteen cases involving the right elbow joint. After the removal of the pieces of bone, the normal motions of the elbow are restored. The condition not being a common one, no doubt goes unrecognized in many instances, and this causes a chronic synovitis and chronic traumatic arthritis.

The diagnosis in all cases can be made by the use of the *x*-ray. Any treatment outside of surgical removal is of no avail.

The last chapter in this most interesting clinical and pathological condition has not been written and only by further study and observations will knowledge be gained.

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TORSION OF OVARIAN CYSTS IN CHILDREN

REPORT OF A CASE WITH RECOVERY

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IT is rather surprising to note that the first case of ovarian cyst with torsion of a pedicle to be reported in the literature was presented in the year 1842 by Carl Rogitansky. It is perhaps just as much a surprise to note that in the ninety-eight years intervening between 1842 and 1940 there have been reported only 119 cases that have occurred in children. A survey of the literature shows that the most frequent age incidence for torsion of an ovarian cyst lies between the ages of twenty and forty. Of the total of 119 cases in children, eleven of them or 13 per cent, have occurred in children under the age of three years. The fact is that 97 per cent of ovarian cysts with torsion of the pedicle occur in adult women rather than in children.

Taking the cases of ovarian cysts without regard to age incidence, a survey of the literature leads one to believe that this condition occurs in 18 to 20 per cent of all ovarian tumors. It is also discovered in this survey that the majority of the cases of torsion occur on the right side rather than on the left, and that this condition also takes place most commonly in simple cysts rather than in other ovarian tumors.

Sneierson and Schlesinger, in their report of the cases occurring in the Binghamton City Hospital, found that between the years 1925 and 1936 there were 221 cases of ovarian tumors. Of this number, there were fifteen cases with torsions of simple cysts and twelve out of the fifteen cases occurred on the right side. The youngest patient was thirteen years of age.

The causes of torsion of the pedicle of an ovarian cyst may be divided into two classes: extra-abdominal and intra-abdominal in origin. The history of extra-abdominal causes include the following: Sudden or frequent abdominal muscle contractions, slipping or falling, lifting of weights and direct trauma. Darner cites the case of a child who was kicked in the abdomen. This trauma was followed by severe and progressive pain and at operation a torsion of the ovary was discovered.

Among the intra-abdominal causes are: The act of defecation or of urination, the shifting of the cyst or tumor because of change in position and the act of vomiting. Payr has shown by models that an increase in the venous pressure of a pedicle without a compensatory change in the arterial pressure will in itself tend to cause this torsion.

This torsion of the pedicle may begin suddenly but the consensus of opinion is that in most cases the actual mechanism of torsion extends over a period of time varying from weeks to months or even years. It has also been believed that the acute symptoms are usually preceded by symptoms of a low grade, chronic abdominal condition for months or even years. The majority of the investigators believe that one can elicit a history of similar but subsiding attacks which have occurred previously.

Two conditions are necessary to permit the occurrence of a torsion of an ovarian pedicle. First of all one must have a free, movable tumor and the second requirement is the existence of a long, membranous pedicle. This pedicle is made up of the upper part of the broad ligament, the mesosalpinx, the tube and sometimes a part of the round ligament. The actual mechanics of the production of this condition is an obstruction of the vessels. The torsion is responsible for this obstruction by causing the thin-walled veins to collapse before the more resistant walled arteries. There

then ensues a condition in which the blood gets into the tumor through the arteries but is unable to escape through the collapsed veins, and a rapid increase in the size of the ovarian tumor follows as a result of this mechanical blockage.

The symptoms of acute torsion of the pedicle are those found in any sudden interference of nutrition to an abdominal viscera. These are: *Pain*, which is apparently dependent on the degree of interference with the blood supply. One can conceive of torsion taking place and still not causing acute symptons until the final stage. This produces acute symptoms giving an example of the theory of Leriche who states that pain is a terminal symptom in any disease. This pain, when the torsion takes place suddenly, is agonizing in character.

Nausea and *vomiting* are constant and are due to the peritoneal irritation.

Shock is supposed to be a constant finding and is to be expected. In the case to be reported, however, shock was either absent or of such a slight degree as to escape attention.

There is also noted an *increase* in the total *white blood cell count* together with a relative increase in the percentage of polymorphonuclear leukocytes.

Muscle rigidity together with *tenderness* on palpation are also among the signs and symptoms.

It is interesting to note that the majority of these cases which have occurred in children have been diagnosed, as in my own case, as appendicitis with abscess formation. In Sneierson and Schlesinger's fifteen cases, all were correctly diagnosed with the exception of one case which occurred in a thirteen year old child and another occurring in a sixteen year old girl. These two cases were diagnosed as acute appendicitis.

The complications of torsion of the pedicle of an ovarian cyst vary, for all practical purposes, directly as the delay in surgical intervention. These complications include: rupture of the cyst with a spilling of septic material into the abdomen with resultant peritonitis, exsanguination of the patient due to rupture of the cyst with intra-abdominal hemorrhage, gangrene of the ovary and adnexae with resulting septicemia.

I wish to report a case of torsion of the pedicle of a cystic right ovary with a resultant gangrene of the ovary and terminal portion of the right uterine tube.

CASE REPORT

The patient was a nine year old female who entered the hospital on October 20, 1940, at 1:30 A.M. complaining of pain in the right lower quadrant of the abdomen.

The day prior, at 6:00 P.M., the patient had a dull ache in her back and went to bed. She had not been straining or playing before this time. Shortly after this, she went to the bathroom and had a defecation of a normal type and consistency. About ten minutes later, she was seized with a severe and agonizing pain in the abdomen and immediately vomited. This vomiting continued at about five to ten minute intervals and according to the history, the pain was not relieved. The pain was of a more or less coliky type and seemed to come and go. It was so severe that the patient "doubled up." The patient stated that her most comfortable position was one with the thighs flexed on the abdomen together with flexion of the knees.

Among the childhood diseases which she had had were measles, mumps and chicken pox. No history was elicited of any attacks similar to this one, nor was there any history of any prior attacks of abdominal pain. There was no menstrual history or history of any vaginal bleeding. The family history was negative in so far as the mother and father were concerned. There were no other children in the family.

Physical examination revealed a well developed, well nourished female child. There were no findings other than those of the abdomen. There was slight muscle guard over McBurney's point and midway between the anterior superior spine and midline. This finding was not present constantly. At intervals of two or three minutes this muscle guard would appear or disappear. There were no masses felt in the abdomen and rectal examination was negative for pain in the right iliac fossa as well

as for a tumor mass. The temperature on admittance was 97.8°F.; pulse, 88; respirations, 26. The laboratory examination revealed a

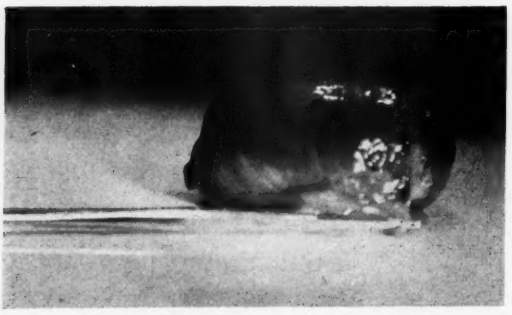

FIG. 1. Gangrenous right ovary.

4,250,000 red blood count with 80 per cent hemoglobin; the total white blood cell count was 10,200. The differential count was 7 per cent stabs, 79 per cent segmenters, 9 per cent lymphocytes and 5 per cent monocytes. The urinalysis showed from 3 to 8 leukocytes per field. Because the patient's history as well as her findings were not more specific, it was decided to adopt an attitude of watchful waiting. The pain, however, did not subside and at 10:00 A.M. of the same day of admittance, or fourteen hours after the first symptom, another examination was made.

Rectal examination at this time revealed a mass in the right lower quadrant. This mass could also be palpated abdominally over McBurney's point. She was taken to surgery with a preoperative diagnosis of acute appendicitis with abscess formation. The abdomen was opened through a gridiron incision and through this incision there was noted a dark, bluish mass. It was necessary to enlarge the incision. A dark, black mass was found in the right lower portion of the abdomen which was the size of a large orange and proved to be a strangulated right ovary. (Fig. 1.) The pedicle was long and the direction of the torsion was clockwise. There were three complete turns. The gangrenous, strangulated ovary was removed together with the tube, which was also involved in the strangulation. The appendix was removed in a routine manner and the abdomen was closed in layers without drainage. The patient's postoperative course was uneventful and her highest temperature was 102 degrees on the first postoperative day with a normal temperature on her third postoperative day. She was discharged from the hospital ten days after admission.

SUMMARY

1. There have been reported in ninety-eight years only 119 cases of torsion of the pedicle of an ovarian cyst in children.

2. The majority of these cases have occurred on the right side.

3. The majority of these cases have consisted of simple ovarian cysts.

4. In spite of the rarity of the condition in children, this possibility should be kept in mind when dealing with an acute condition of the abdomen in female children.

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PUERPERAL SEPTICEMIA FOLLOWING SPONTANEOUS DELIVERY*

REPORT OF A FATAL CASE

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IN view of the successful treatment of puerperal septicemia with the sulfanilamide preparations, notably the work of Colebrook and Purdie[1] at Queen Charlotte's Hospital, London, we think it of interest to report the following fatal case:

CASE REPORT

B. C., No. 75116, a thirty-four year old white woman, gravida 2, para 1, was admitted to the Bronx Hospital at 4:00 A.M. on March 14, 1937, because, as she stated, her membranes had ruptured at 12:00 midnight. The past history was negative, and the course of the present pregnancy had been normal until the rupture of the membranes. The expected date of confinement was April 12, 1937.

On admission, rectal examination showed an undilated, thick cervix; the presenting part was irregular in outline and unengaged. A breech presentation was suspected until the roentgenogram showed an unengaged vertex. No vaginal examinations were made during the entire labor.

Labor began at 3:00 P.M. on the day of admission. At nine the next morning, March 15, the cervix was only one finger's breadth dilated.

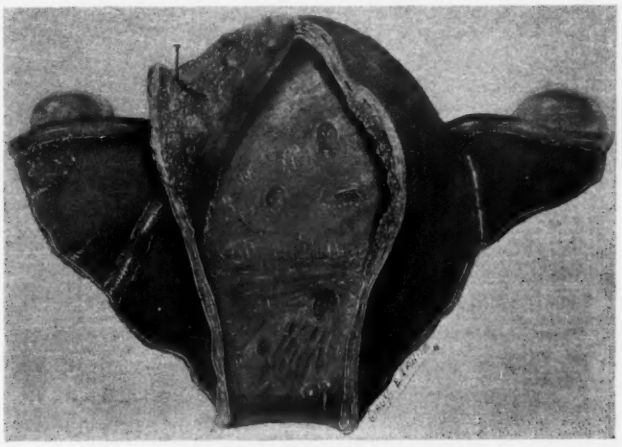

FIG. 1. The uterus. Notice the ulcers in the fundus and the Nabothian cysts in the cervix.

The fetal heart was strong and regular, the rate being from 130 to 140. At three o'clock that afternoon, the cervix was two fingers' width dilated and the head engaged. The fetal heart was then irregular. Meconium was noticed at 3:15 P.M. At that time, the lack of dilatation made vaginal operative delivery impossible. On consultation, it was decided that cesarean section was contraindicated because of first, the engaged presenting part, and, second, the thirty-two hours of ruptured membranes. By 6:00 P.M. the following day, March 16, the pains had become severe and frequent. At seven o'clock, the fetal heart could not be heard, and the dilatation of the cervix was still only two fingers' wide. At 10:45 P.M., the patient was spontaneously delivered of a six-pound stillborn male child with three tight loops of cord about its neck.

For the first four days postpartum, the patient had a profuse, foul lochia. Her temper-

* From the Obstetric Service of the Bronx Hospital, New York City. Read Before the Section of Obstetrics and Gynecology, New York Academy of Medicine, December 27, 1938.

ature rose the first day to 102.4°F. and then varied between 98 and 100°F. for two days. On March 21, the fifth day postpartum, she had a sudden, severe chill, with elevation of temperature to 105°F. The lochia then became scant, thin and odorless. Cervical, vaginal, nose, throat, blood and urine cultures were taken.

FIG. 2. The enlarged right kidney with an infarct.

FIG. 3. The enlarged, toxic spleen, sectioned through one of the two infarcts.

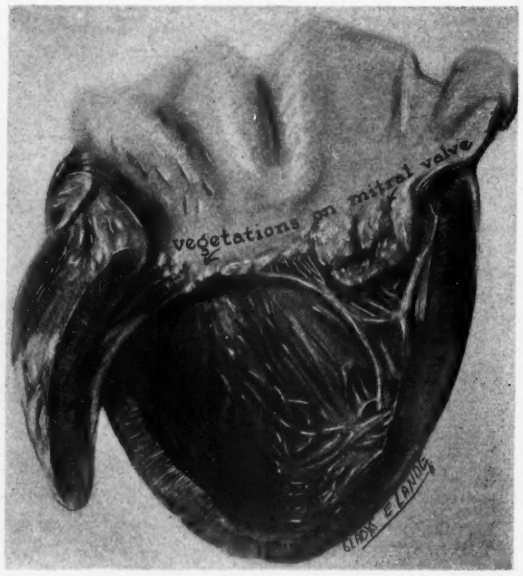

FIG. 4. The heart, showing vegetations on the mitral valve.

Except for the nose culture, these were all positive for *Streptococcus hæmolyticus*, beta type. Treatment with prontosil and prontylin was instituted; the patient received 20 cc. of prontosil intramuscularly, followed by 20 gr. of prontylin every four hours—a total of 100 cc. of prontosil and 360 gr. of prontylin during the course of the illness.

A blood count taken March 24 showed: hemoglobin 73 per cent, red blood cells 4,080,000, white blood cells 9,200, of which 68 per cent were polymorphonuclear neutrophiles. Tests for methemoglobin and sulphemoglobin were negative. Blood Wassermann and Kahn reactions were likewise negative.

On March 30, a systolic murmur was noticed at the apex. On the next day, the loud, blowing systolic murmur led to the diagnosis of endocarditis. On April 1, the blood count was: hemoglobin 66 per cent, red blood cells 4,200,000, white blood cells 10,100, of which 71 per cent were polymorphonuclears. On the evening of April 1, the patient became cyanotic and dyspneic, and râles were heard throughout the bases of both lungs. She was then placed in the oxygen tent. The family doctor stated on April 2 that he had treated her for erysipelas a year previously. An intravenous injection of 100 cc. of scarlet fever convalescent serum was administered that same day. Supportive measures consisted of intravenous glucose and of two blood transfusions, one of 350 cc., and one of 500 cc. Nevertheless, the patient's condition gradually became worse. Her blood pressure dropped from 130/80 to 90/55. The spleen and liver were palpable. She died on April 3, the eighteenth day after delivery.

The salient findings of the postmortem examination were as follows:

The uterus (Fig. 1) was enlarged to 14 by 10 cm., regular in outline, and soft in consistency. The external os was congested and patent. When the cervical canal was sectioned,

many Nabothian cysts were seen near the external os. There was extensive ulceration of the endometrium, particularly near the opening of the left tube. The site of placental attachment was indicated by softness and congestion of the endometrium. There was thrombophlebitis of the veins of the parametrium.

The kidneys were enlarged and congested, each weighing 250 Gm. Figure 2 shows the right kidney, sectioned through a yellowish, wedge-shaped infarct measuring 2 by 1 cm.

The spleen was markedly enlarged. The pulp, on section, was soft and dark red. Two infarcts were observed. One, measuring 2 by 5 cm., was yellowish, with a depressed center; the other, measuring 2 by 2 cm., was purplish and wedge-shaped. (Fig. 3.)

The lungs showed considerable edema, with marked congestion in both bases. There were fresh pleural adhesions to the right upper lobe.

The heart (Fig. 4) was normal, except for the mitral valve, on which was a round vegetation, measuring 2 by 2 cm., whitish in color, soft, and exceedingly friable; similar smaller vegetations were also present.

The cause of death was reported by the pathologist as acute bacterial endocarditis occurring in the puerperium.

SUMMARY

A case of puerperal septicemia is reported, the interesting features of which are:

1. The birth was spontaneous and no vaginal examinations were made.

2. The patient developed puerperal sepsis.

3. The patient died despite early diagnosis and prompt treatment by approved methods. Not only was the causative organism (the beta hemolytic streptococcus) identified before death, but the endocarditis was also recognized. The diagnosis was confirmed by complete autopsy.

4. The patient had had erysipelas a year before. This raises the question of individual susceptibility to the streptococcus.

The author wishes to express his appreciation of the valuable assistance given by Dr. Joseph Felsen, Director of Laboratories and Research at the Bronx Hospital.

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LIVER ABSCESS CAUSED BY BACTEROIDES FUNDULIFORMIS*

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THERE has appeared in the literature from time to time cases of bacteremia and/or liver abscess caused by the organism of the species bacteroides (more recent classification: necrophorum) most of which have been fatal.

This is a case of liver abscess caused by fusiformis funduliformis successfully treated by chemotherapy and surgery.

Bacteroides funduliformis[1] belongs to a group of Gram-negative nonsporulating anaerobes which show marked morphologic pleomorphism with production of filaments and require animal tissue in culture media for growth. The French workers[2] have ascribed to Bacteroides funduliformis the cause of many pathological conditions in man which resemble Bacteroides necrophorum infections in animals. They attribute the predominance of liver abscess caused by this organism to its nonsporulating anaerobic character producing necrosis of the mucous membrane of the large gut which is the usual habitat. When the bowel becomes ulcerated from any condition, these organisms multiply rapidly and hence are readily transmitted via the portal system to the liver. Another French report[3] describes primary septicemia due to Bacteroides funduliformis emphasizing its tendency to produce foci of circumscribed necrosis in the parenchyma, especially the lungs and liver. They further remark on the resemblance of symptoms to septicemia caused by aerobic organisms. The prognosis of septicemia with the organism is grave, three out of four succumb. Hepatic and pulmonary localizations are the most serious; these are usually fatal within a short time (eight days, thirteen days, five weeks).

The Mayo Clinic[4] reported two cases of fatal bacteremia, but more lately reported a successful case,[5] treated with massive doses of sulfathiazole.

CASE REPORT

C. B., a married Latvian housewife, age forty years, was admitted to Methodist Hospital on October 22, 1940, service of Dr. H. K. Bell, with the complaint of intermittent shaking, chills and fever, accompanied by epigastric pain and nausea with vomiting of four days' duration. Her chills were most severe and lasted about one hour; they had come on very suddenly and she stated she was perfectly well four days previously. The epigastric pain was nonradiating and played a minor rôle in comparison with here severe chills. Her past history was essentially negative except that she had had three miscarriages, one induced followed by a rather "stormy course" about two years previously.

On physical examination there presented a moderately obese, foreign middle-aged lady in the midst of a severe shaking chill and obviously acutely ill; temperature 102°F., respirations 20, pulse 80 and blood pressure 120/60. There was no cyanosis nor jaundice. There was a moderate degree of Herpes simplex of the upper lip. Alae nasae were not active. Lungs were resonant and clear throughout, except at the right base where there were signs suggestive of an elevated diaphragm. The heart was not enlarged; regular sinus rhythm, no murmurs, aortic second sound greater than pulmonic second sound, and sounds were of good quality. The abdomen was slightly obese but easy to palpate and revealed no palpable viscera nor masses. There was no tenderness nor rigidity. The pelvic, rectal and neurological examinations were completely negative. The impression was that of liver abscess.

* From the Second Surgical Service of Dr. H. K. Bell, Methodist Hospital, Brooklyn, New York.

The laboratory findings were as follows: Complete blood count: hemoglobin 11.4 Gm., red blood cells, 3,910,000, white blood cells, 13,850, blood non-protein nitrogen, 34 mg. per cent, blood sugar, 107 mg. per cent, polymorphonuclear leukocytes, 84, total serum protein, 7, lymphocytes, 15, albumin, 4.9, eosinophiles, 1, globulin, 2.1, blood Wassermann and Kahn negative, icteric index, 3, urine completely negative, blood culture negative after twenty-four hours.

Because of the apparent infectious nature of her disease, she was immediately started on a régime of sulfathiazole, 1 Gm. 8.4 h. with an equal amount of soda bicarbonate. The reason for the latter was in hopes of obtaining an alkaline urine thereby minimizing renal complications caused by the sulfathiazole crystals, and also to obtain maximal absorption from the gut. However, never once did we obtain an alkaline urine nor did we run into renal complications in spite of the fact that sulfathiazole crystals were seen in the urine on numerous occasions.

The patient spiked a temperature to 106.8°F. on one occasion, but it fluctuated mainly between 100.0°F. and 103.0°F. This continued for twelve days. Because our blood sulfathiazole levels never revealed more than a "faint trace," we increased the drug to 1.5 Gm. 8.4 h. for twelve days. Still the spiking temperature continued; blood sulfathiazole levels now were 2.1 mg. per cent. For forty-eight hours we administered the drug in 2.5 Gm. doses 8.4 h. The blood level remained the same. Throughout these twenty-six days, numerous blood cultures were taken at the peak of the temperature but all were negative. Ordinary culture media was used, however. Spinal tap revealed normal spinal fluid under no pressure. Colloidal gold curve negative as was the Wassermann. On an attempt to find an organism blood agglutinations tests for Mellitensis and Abortus were negative on two occasions. Widal test was negative on two occasions. Throat culture revealed Staphylococcus aureus. Cervical smear revealed hemolytic streptococci, alpha type; feces were negative for the dysentery group of organisms and a smear revealed no ova or parasites.

X-ray of the chest revealed some obliteration of the costophrenic angle on the right; flat plate of the abdomen was thought by some to show an enlarged right lobe of the liver. Intravenous pyelography showed a well functioning genitourinary tract. A gallbladder series showed a pathological response; no calculi were seen.

Believing that the liver was definitely the seat of her infection, the patient was fluoroscoped in preparation for operation. Both diaphragms moved well, but the right was felt to be higher than normal. At this time the tip of the liver could be felt for the first time. It was nontender. Further blood work revealed a serum phosphatase of 6 Bodanski units rising to 8.5 Bodansky units in nine days. The Hangar test was two plus and plus minus on two occasions, all indicative of a damaged liver.

She continued to run a leucocytosis (26,700 11,800) but developed no anemia. On her twenty-sixth day in the hospital, after having received a total of 197 Gm. of sulfathiazole, the patient was taken to the operating room for a peritoneoscopy and laporotomy with the provisional diagnosis of liver abscess, etiology unknown. With the peritoneoscope Dr. C. Douglas Sawyer demonstrated about the righ lobe of the liver a peculiar greyish appearance, with the gallbladder pushed up anteriorly and mesially. Dr. J. H. Bliss made a small oblique incision over the right lobe of the liver coming down directly on a large abscess in the liver substance. By means of suction about 500 cc. of foul smelling, dark greyish, brown pus was obtained. The cavity was drained. Culture of the pus revealed aerobically no growth, but anaerobically a pure culture of Bacillus funduliformis.

We have had such good results in postoperative infected peritoneal cavities with sulfanilamide hypodermoclyses (8 Gm. per 1,000 cc.) that we administered them to this patient for twenty-four hours, 500 cc. the first dose, followed by 250 cc. every 6 hours. This brought the blood sulfanilamide level to 5.4 mg. per cent. We then continued sulfanilamide by mouth, 1 Gm. every 4 hours for another forty-eight hours, but nausea and vomiting became distressing and chemotherapy was discontinued.

Postoperatively the patient's temperature did not level off, but rather continued to fluctuate from 100.0°F. to 103.0°F., the highest being 104.0°F. on her ninth postoperative day. At this time clinically we believed there were signs of pneumonia developing at the left base, and we feared pulmonary complications caused by Bacillus funduliformis. *X*-ray showed only congestion at both bases, and sputum typing

came back: Pneumococcus, type 6. Sulfathiazole was now begun, 1 Gm. every 4 hours. She obtained a total of 44 Gm. The blood level never reached higher than 2.7 mg. per cent. The chest signs cleared, but the temperature never leveled off until the forty-fifth postoperative day.

The wound healed slowly, and for weeks we were able to asperate foul pus; on the twenty-fourth postoperative day Bacteroides funduliformis could still be cultured but not now in pure culture.

A slight anemia (8 Gm. Hgb.) was present on her forty-fifth postoperative day, which was relieved by two indirect transfusions of 500 cc. each. She was discharged on her eighty-sixth day in the hospital, the temperature having been normal for one week, with still a moderate leucocystosis and a small sinus tract in the wound.

Follow-up, of course, has been rather short, but she has been seen in the dispensary regularly and has rapidly regained her good health. She has remained afebrile, and her wound has closed except for a small sinus tract one inch deep, draining occasionally thin sterile pus.

COMMENT

We believe that both chemotherapy and surgery contributed to this patient's recovery. Doubt remains in our minds if this patient had a blood stream infection, but many are certain that she did and also that pulmonary and other visceral abscesses were prevented because of the chemotherapy. It is interesting that the blood levels remained so low in spite of intensive administration of the drugs and yet a therapeutic effect was obtained.

SUMMARY

A forty year old female recovered from liver abscess caused by Bacteroides funduliformis after receiving 241 Gm. of sulfathiazole and 24 Gm. of sulfanilamide. Incision and drainage of the abscess were performed after its exact location was ascertained by peritoneoscopy.

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BRENNER TUMOR OF THE OVARY*

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FIRST described by Brenner in 1907 under the name of *oophoroma folliculare*, the Brenner tumor of the ovary is now an established morphologic entity. Brenner as well as other investigators confused the growth with granulosa cell neoplasms. In 1932, Mayer clearly differentiated the two and reported twenty-two cases of this type of tumor. Additional cases have since been recorded and the number of reported cases, at present, according to Novak, is about 130.

The tumor occurs most often in women past the menopause, and in over 50 per cent of cases above the age of fifty years. No true Brenner tumor has been reported in a child.

The histogenesis is obscure. Meyer and most other investigators believe the neoplasm arises from Walthard inclusions within the ovary. Other authors suggest its origin from metaplastic ovarian epithelium. Schiller attributes the origin to abnormal persistence of the embryonic relationship between the epoophoron tubules and the rete ovarii in the hilum of the ovary. Other writers champion the view of its derivation from mesenchyme.

Almost always unilateral, the neoplasm occurs as a solid nodule on the ovary or as a nodule in the wall of a pseudomucinous cyst. Most often small, the size, nevertheless, varies within wide limits. Neiman reported one Brenner tumor which weighed fifteen pounds. It is relatively slow in growing, benign and frequently discovered accidentally. Histologically, it is composed of nests or columns of epithelial cells lying in a fibrous connective tissue stroma. The cells are pale-staining, fairly uniform in size and contain vesicular nuclei. They do not show any of the variations in cell structure which are generally associated with malignancy. Mitotic figures are extremely rare in these tumors. According to Novak and as far as can be gleaned from the literature, not a single authentic case is reported which has recurred after removal.

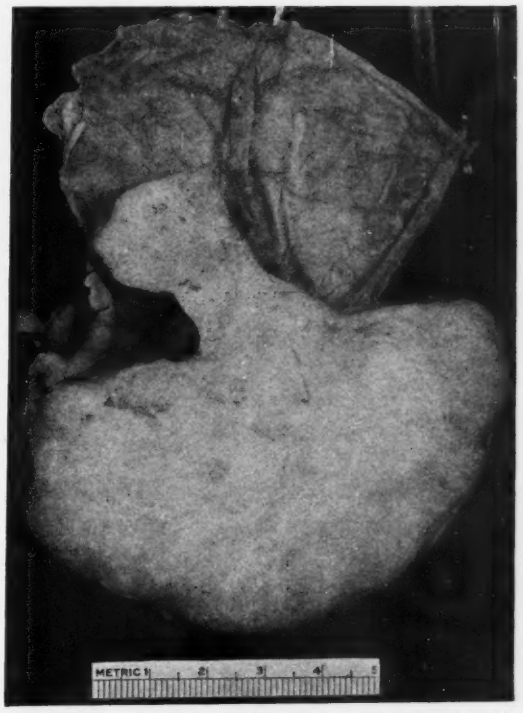

FIG. 1. Gross specimen showing cyst wall (above) and solid tumor (below).

Attempts have been made to subdivide Brenner tumors into solid and cystic varieties. This subdivision, however, is not a sharp one since in the solid tumors small cysts have been found frequently while even in the larger cysts solid nests of cells may be present within the cyst walls.

There is no characteristic symptomatology nor is the menstrual flow altered according to any definite pattern. A small number of cases present postmenopausal uterine bleeding or irregularity in men-

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struation. With this, in some cases, endometrial hyperplasia is associated. It is extremely doubtful, however, whether this is the result of any endocrine effect upon the endometrium.

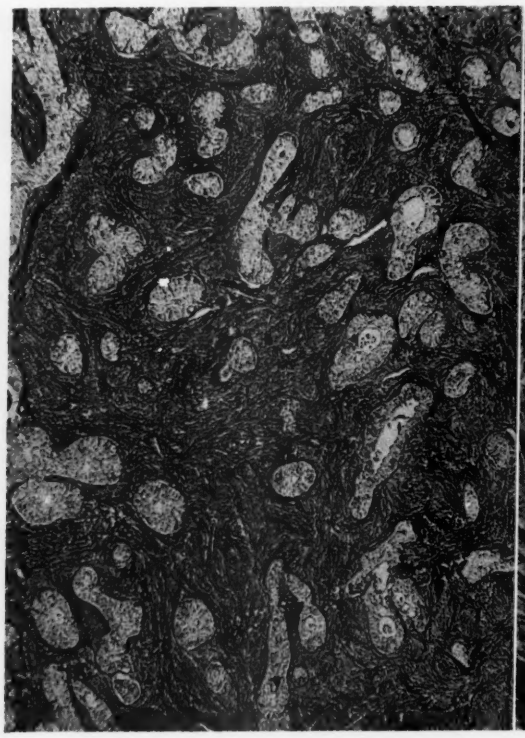

Fig. 2. Hemotoxylin eosin stain. Nests of epithelial cells in fibrous tissue stroma. × 100.

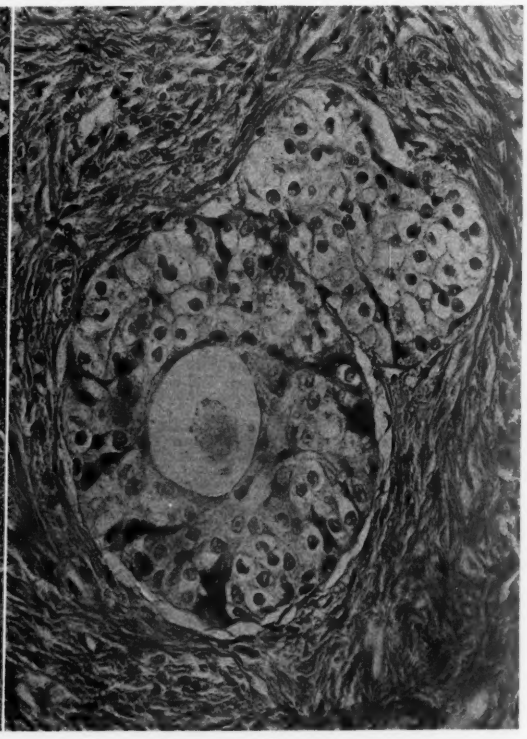

Fig. 3. Same as Figure 2. × 450.

CASE REPORT

S. S., white, sixty-eight years old, was admitted to The Jewish Hospital of Brooklyn, on the service of Dr. A. Bonner on September 10, 1940, complaining of postmenopausal vaginal bleeding of one year's duration.

The family history was irrelevant. She had suffered from hypertension for seven years and experienced mild exertional dyspnea and nocturia. The patient had been married for forty-eight years and had been pregnant six times. One pair of twins and five other children were born. Five were stillbirths. Her climacterum occurred twenty years previously and was associated with hot flushes.

One year before admission she noticed spotty vaginal bleeding which was associated with right, lower quadrant pain. She consulted a local physician who advised and administered a series of twelve *x*-ray treatments to her pelvis. The bleeding became less profuse but did not stop altogether. Three weeks before admission the bleeding became more profuse. Small clots were passed. She likewise developed engorgement and tenderness of the breasts which persisted until a few days before admission. The general physical examination was essentially negative; pelvic examination revealed the presence of a large mass in the right fornix.

On September 11, 1940, a right salpingo-oophorectomy was performed with removal of a partly cystic, partly firm ovarian mass and attached right fallopian tube. The uterus, left fallopian tube and ovary were normal. Her immediate postoperative course was uneventful. However, on the ninth postoperative day, partial evisceration of the small bowel was noted. The bowel was reposited and the wound strapped tightly with adhesive tape. Thereafter the wound healed satisfactorily and she was discharged on September 30, 1940, in good condition.

Pathological Report. The specimen (Fig. 1) consisted of a large, partly cystic and partly firm mass, representing the right ovary, to which was attached the right fallopian tube. It measured 13 by 12 by 6 cm. The upper pole of the mass was gray-pink and fluctuant whereas the lower pole which measured 11 by

6 by 5 cm. was firm, irregularly nodular and gray-red. On section the cystic portion was multiloculated and contained pseudomucinous material. The solid portion cut with considerable difficulty revealed in the cut surfaces bundles of gray, pale brown, and white fibers arranged in whorls. At the periphery there was a slight mottling with yellow. The fallopian tube was attached to the mass at the point where the solid mass met the cystic portion. It measured 10 cm. in length and its fimbriated extremity was patent.

Microscopically, the tumor consisted of a dense fibrous stroma in which were scattered various sized nests of large, fairly uniform, pale-staining cells with distinct outlines. (Fig. 2.) Some were polyhedral in shape, others were epithelioid or spindle-shaped. The nuclei were round or ovoid and vesicular with a fine chromatin network and small nucleoli. Toward the center of the nests the cells were somewhat larger and the cytoplasm clearer. Many of the islands had cystic centers (Fig. 3); some of these were empty, others contained pink and lavender staining masses intermingled occasionally with desquamated and degenerating cells. The cysts were lined by several concentric rows of flattened cells, though in some, the innermost layers were composed of well defined columnar cells. The larger cyst was lined by tall columnar cells which rested on a narrow band of dense fibrous connective tissue. No fat could be demonstrated with the Scharlach R or Hoerr-Romeis stains. *Diagnosis:* Brenner tumor of ovary.

SUMMARY

A case of Brenner tumor of the ovary has been presented.

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MASSIVE INTESTINAL HEMORRHAGE IN REGIONAL ENTERITIS*

REPORT OF A CASE

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THE presentation of this case report is prompted by the finding at operation of regional enteritis in a patient whose outstanding preoperative symptom was repeated and profuse intestinal hemorrhage. None of the other twenty-seven patients with regional enteritis who have been treated at the Henry Ford Hospital have presented this symptom nor have I been able to find a similar case recorded in medical literature.

CASE REPORT

A Rumanian factory worker, age fifty-four years, was admitted to the Henry Ford Hospital September 30, 1939 for the treatment of subacute intestinal obstruction.

During the past four years he had occasionally experienced periumbilical distress, mild nausea and vomiting following overindulgence in food and drink. Five weeks previous to admission he began to suffer from repeated attacks of abdominal pain and vomiting which gradually increased in severity. The attacks were complicated by abdominal distention and the passage of large quantities of bright red blood per rectum. At another hospital the distention was treated by means of intestinal intubation for five days when the attack subsided. A complete gastrointestinal *x*-ray series was negative at that time and also a repeat examination made ten days later. Following discharge from the hospital he remainded at home for three weeks, unable to work because of increasing weakness. During this period he suffered from anorexia, frequent watery stools and lost seventy pounds in weight.

On admission the patient was not acutely ill and there was moderate abdominal distention with some tenderness in the right lower quadrant. White blood count was 14,000, polymorphonuclear count 83 per cent; temperature 99.6°F., pulse 90. Sigmoidoscopic examination was negative to ten inches. Flat abdominal *x*-ray films showed many dilated loops of small intestine.

The week after admission the patient fainted after getting out of bed, and later passed a large amount of blood per rectum. Blood pressure was 85/50. He bled so freely during the next two weeks that he received in all eight blood transfusions. Serial *x*-rays now revealed evidence of obstruction in the terminal ileum. In an effort to explain the profuse bleeding, small bowel malignancy and Meckel's diverticulum were the diagnoses considered.

Operation was performed in October 30, 1939 under spinal anesthesia. A typical regional enteritis involving twenty-seven inches of the terminal ileum was found. Resection of thirty-three inches of terminal ileum with end-to-side anastomosis of ileum to cecum was performed. A Hendon[1] enterostomy tube was inserted twenty-four inches proximal to the anastomosis.

The postoperative course was uneventful. The ileostomy tube was cut flush with the skin on the tenth postoperative day. The patient left the hospital on the eighteenth day after operation and returned to work four weeks later.

The specimen showed changes typical of regional enteritis. The mesentery was thickened and contained many enlarged nodes. The serosa was moderately thickened with areas of congestion and hemorrhage. The mucosa was eroded by many ulcers varying in size up to 3 cm. in diameter. (Fig. 1.) Microscopically there was nothing to suggest any specific type of inflammatory process.

During the past eighteen months the patient has worked regularly and has been free of gastrointestinal symptoms. There has been no recurrence of intestinal tract bleeding.

* From the Department of Surgery, Henry Ford Hospital, Detroit, Michigan.

COMMENT

Since Crohn and his associates,[2] in 1932, revived interest in chronic nonspecific inflammatory lesions of the small intestine, numerous contributions on this disease have appeared in the medical literature. A review of these case reports fails to find record of serious intestinal hemorrhage occurring in any of the patients studied; on the contrary, most authors comment on the rarity of blood in the stool. Shapiro,[3] in an excellent summary of the literature in 1939, says that in the ulcerative type of enteritis, the stools contain mucus and blood, but no grossly visible melena. Dickinson et al.,[4] George Crile, Jr.,[5] and Mixter,[6] all make similar statements, as does Crohn[7] in his latest contribution. Bargen[8] in his most recent summary of the symptomatology of regional enteritis does not even refer to bleeding, but did mention the occurrence of massive hemorrhage in a previous discussion[9] of the disease though he did not cite an actual example.

This case, however, shows that regional enteritis must be considered in the differential diagnosis of massive intestinal hemorrhage even though bleeding is a rare symptom of this disease.

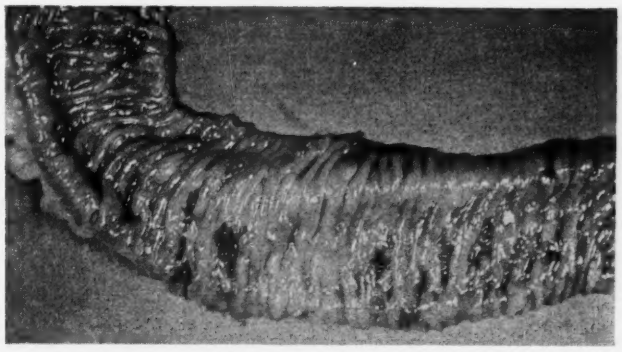

Fig. 1. A portion of the terminal ileum showing the ulceration of the mucosa.

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USE OF A VITALLIUM TESTICULAR IMPLANT

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IN young males, orchidectomy frequently induces considerable psychic trauma. Because of the invariable failure of free organ transplants in humans, molded foreign bodies as ivory have been employed with some degree of success.

In 1937, vitallium, a nonferrous alloy of chromium, cobalt and molybdenum was introduced by Venable and his associates as the metallic material evoking the least reaction from human tissues. The more recent literature has demonstrated two very desirable qualities of this alloy. It is extremely inert and apt to be tolerated even in the presence of infection. Campbell and Speed have used it successfully as an internal fixative in the treatment of infected compound fractures. Vitallium is so strong that Smith-Petersen found it ideal for the formation of molded caps in hip arthroplasties where they meet the strain of weight bearing. In his more recent arthroplasties, he intends to leave the caps in place indefinitely rather than remove them at a later stage.

These two characteristics would lend themselves to the use of vitallium for a free testicular implant which of necessity is placed in a position permitting easy direct trauma. To our knowledge, it was first used successfully for this purpose by Dr. Ralph Bowers of New York City in 1939.

CASE REPORT

The patient was a twenty-seven year old, single male who had an orchidectomy performed three years ago for trauma. The other testis was normal. Because of the deformity, the patient who was of a particularly sensitive nature developed serious fits of depression.

Prior to operation, a hollow vitallium implant* was molded to the size, shape and weight of a normal testis. This was boiled for sterilization. On August 28, 1940, the operation was performed under gas, oxygen and ether anesthesia. A low inguinal incision, one inch long was carried to the level of the fascia of the external oblique. By blunt dissection, a pocket three-quarters of an inch in diameter, was burrowed subcutaneously to the free border of the scrotum. Slight bleeding was controlled by ligatures and the implant was inserted into place. Two catgut purse-string sutures were passed at the neck of the pocket to prevent it from rising subcutaneously toward the abdomen. The skin incision was closed without drainage and the scrotum was elevated with adhesive tape. The entire operation lasted seven minutes.

Postoperatively, there was slight transient local edema but no systemic reaction. The patient was out of bed on the third postoperative day and resumed his normal activities three days later. Since then, he has led an active life as a sailor in the United States Navy. Examination on May 5, 1941, revealed no local reaction about the implant and there is considerable mobility of the artificial testis in the scrotum. The only recognizable difference between it and the other normal testis is its cold, metallic feel. There have been no subjective symptoms and the patient's mental outlook has returned to normal. Dr. Bower's case with a year's follow-up has revealed similar satisfactory results.

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* Supplied by the Austenal Laboratory of New York City.

New Instruments

A MODIFIED KIELLAND FORCEPS AND PRINCIPLES OF APPLICATION

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I AM herewith presenting a modification of the Kielland forceps which can be employed with equal facility and less difficulty than the original instrument or the standard English or American designs of forceps. It can be used in high, median and low pelvic planes in normal positions as well as in occipitoposterior and transverse presentations.

Whatever view one may hold regarding the superiority of the Kielland forceps, there can be no difference of opinion as to the value of its sliding lock. This is a momentous and revolutionary device and would mark a stride in the progress of obstetrical technic if it were universally employed on every design of forceps where possible. I have had made and used to advantage models of Naegele, Simpson and other types of forceps with the Kielland sliding lock and Kielland handles. The Tucker McLane instrument is the least adapted for this purpose. On account of the sliding lock an element equivalent to a degree of elasticity is imparted to the forceps, and such an instrument makes it easier to execute a cephalic application and extraction and will even correct an asynclitism if present. Should an imperfect application be made or a pelvic application instead of a cephalic one, there is usually a spontaneous biparietal adjustment during the process of traction and its intervals; and, if no adjustment takes place, there is no harm done if traction is made in the manner to be described.

The best results, however, have been obtained from the model (Figs. 1 and 2c) which I have used in approximately 400 cases. It has a Kielland sliding lock with modified Kielland handles, and a prolonged but moderate pelvic convexity with a somewhat narrower, longer and straighter fenestra than that of any of the English or American styles. This enables it to be used as the regular Kielland forceps but with less confusion, greater ease of application and with equal or more benefit to infant and mother. The absence of pressure marks on heads of fetuses delivered with this forceps is significant and striking. The blades in the Kielland forceps are rotund in the cephalic diameters while in my modification they are ovoid, thus facilitating a closer grasp of the head. This is particularly important when rotation of the head is indicated and the Kielland blades will often rotate or slip around the head with failure of the head to follow. The ovoid shape of the blades in my modification causes them to end in an acute angle at the shanks instead of a wide obtuse angle or an arc of a circle as is the case with the Kielland types. The blades ending in an acute angle, not unlike that of the Simpson or Naegele type of forceps, help to prevent perineal tears or extension of an episiotomy by gradual distention of the perineum, simulating more closely spontaneous delivery. With the Kielland forceps in primipara, episiotomy is imperative.

I wish to set forth a number of points in technic which I have found to be of advantage:

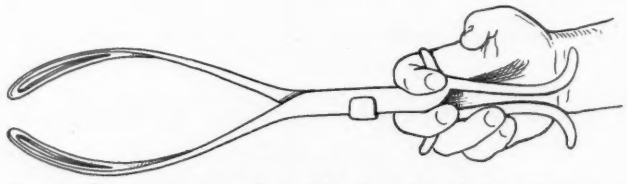

Fig. 1. Space between tips of blades 1 5/16 inches. Distance between highest point of direction of forceps and flat surface on which blades are resting, 2 inches. Distance between points of direction of the blades and point on the blades directly opposite 1 5/8 inches. Widest transverse diameter between inner surface or blades, 3 1/2 inches. Space between tip of blades and angle of shanks 7 1/2 inches. Space at narrowest point betweent apering handles 3/8 inch.

TECHNIC

In applying the forceps the points of the blades should at first be directed to the midline and posteriorly where there is more space between the head and the cervix than laterally. The ends of the blades so directed and hugging the head and neck until they are in position will insure the passage of their tips between the cord and the neck should the former be so exposed.

Given a woman, without real or relative pelvic disproportions, who has been in labor hours beyond the time considered average, with danger to mother or child or both, and the cervix dilated only four or five fingers, the first thought under the circumstances is to do Dührsen incisions on the cervix and perform a forceps delivery. This is the correct and logical procedure. Time in such cases is an element of value and any technic that would expedite the saving of time in such a contigency is an improvement over other methods. It can be accomplished as follows: Apply forceps in the routine manner. It will now be found that between the external os and the shank end of the fenestra there is a space of from 1/4 to 3/4 inch. Through this space a blunt pointed scissors is introduced, directed from within outward and the cervix is grasped and cut between the blades to the extent of about 1/2 inch. The same technic is repeated on the opposite side. The depth of the incisions is gauged with the index finger or index and middle fingers of the free hand. The anterior lip of the cervix at this time is low and tense and an incision can be made directly into it extending to 1/4 to 3/8 inch without fear of injury to the bladder. If an anterior cervical incision is anticipated, it is preferable to do it before attempting the lateral ones. I have had occasion to resort to this emergency operation a number of times with complete satisfaction.

Traction is made with the index and middle fingers grasping the proximal flanges from below upward, the palmar surface of the hand facing but not touching the undersurface of the handles. (Fig. 1.) Traction is thus made with the fingers only. Only in this way can the axis traction principle be perfectly imitated and maintained and delivery accomplished with the expenditure of a minimal amount of force. The axis traction principle is applicable and indicated in every form of forceps delivery, and any other manner of holding the handles in employing traction with a nonaxis traction forceps is simply working against oneself, against impediments and relative disproportions created by the operator in the faulty technic of traction. Only in traction as thus indicated can the handles point as a guide in the direction of the "pull," or more correctly, in the direction of the "yield" of the head, and delivery terminated much easier and with none or minimal damage to the child or the soft

structures of the pelvis. When progress is slow, the strain of the fingers will soon be felt. In such an eventuality the index and middle fingers of the left hand are placed posteriorly and in the opposite direction to the fingers of that of the right hand as a complement, or the whole left hand grasps the shanks as is the Saxtorph maneuver, but instead of using pressure backward it is directed outward principally in line of traction. Supplemental force thus applied does not change the principle of axis traction.

If spontaneous or manual rotation of the head fails, and traction on the head with forceps likewise fails or is anticipated to fail, such as in positions of occiptoposterior or transverse in high or midplane, the rotation is done with the forceps applied, a small arc of a circle at a time, as small or as large an arc as the intervals between inspiration will permit. This is easily accomplished because during anesthesia the inspirations are deep and the expirations are relatively long with a concomitant degree of relaxation. If a Scanzoni technic of rotation is started and an anterior position obtained by rotation or traction, no reapplication of the forceps is necessary for the termination of the delivery. On account of the shallow pelvic curve the delivery may be accomplished with the directing points of the blades facing backward, that is, opposite to the point of direction of the head. With the axis traction technic such delivery is relatively simple. A reapplication may be done if one feels so inclined.

Infrequently, despite the best judgment, we find ourselves enmeshed in labyrinthine extremities and the only light we see is the vision of a live mother; and all our emotions, anxieties and thoughts are streaming to the focal light of a live mother, and we dare not divert or deviate our thoughts to aught else but the vision of that live mother. Then the pyramidal handles with the crowning flanges come in for their share of victory or defeat in the life or death of the fetus. The fetal head can stand an amount of molding which it usually receives during the process of labor. Frequently it does not receive the molding it can stand or the molding necessary for

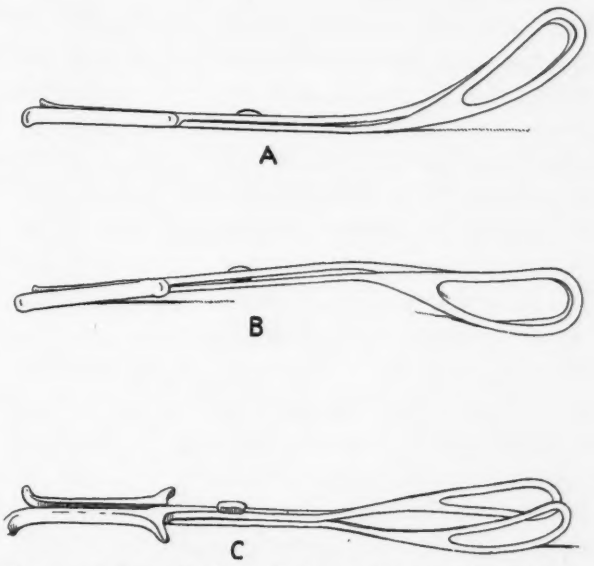

Fig. 2. A lateral view of the model showing clearly outstanding contrasting features of three types of forceps. A, is the Naegele type (the curves in the Simpson forceps are similar). B, is the Kielland forceps. C, is my modified Kielland type. It combines the features of the Kielland and American or English types and can be used as either but with more facility and advantage to the mother and child. Note the tapering handles as a special feature.

delivery due to the fact that the uterine contractions are not sufficient to accomplish the same, although judged by themselves or the amount of pain they cause they are apparently relatively powerful. The majority of these cases will stand further compression with forceps without impunity, and particularly so by the forceps possessing the accommodation and elastic resilience inherent in the instrument with the sliding lock. It will be noticed that the handles of my forceps taper outward and the flanges at the end are more pronounced actually, and relatively more on account of this tapering than in the Kielland instrument. With traction on these outer flanges the axis traction principle is somewhat reduced; but the force of the pull is greater with no more exertion of strength, because the lever is longer to the extent of the space between the outer and inner flanges.

The principle involved is not unlike the law of lever-fulcrum-weight, wherein the longer the lever the less force is required to elevate the weight, excepting in this case the elevation is substituted by "pull" or traction; or, in other words, instead of the weight being elevated it is pulled or drawn forward. I have proved this principle in practice over and over again by having an adult insert his fist between the blades so as to fit in as snugly as possible and then traction is made alternately on the flanges, the inner or proximal ones and then on the outer or distal ones. It will be seen invariably that when traction is made on the proximal flanges the arm (flexed) can resist the pull while with traction on the outer or distal flanges, using the same amount of resistance and the same amount or less of traction, the resistance is easily overcome. Using traction on the outer flanges causes a closing in of the blades with increased compression of the head equivalent to molding. Compression of the head plus increased traction will as a rule deliver the child, but with intensity of the pressure tempered by qualities generated directly from the source inherent in the sliding lock. Should strain on the fingers be manifest, the process of delivery may be aided with the fingers of the other hand applied in reverse order on the proximal flanges, or with the hand in the position of the Saxtorph method at the shanks, for the purpose principally of aiding traction. Co-operation with the left hand on the shanks or flanges as described does not increase compression of the head; it simply facilitates traction.

A NEW SPONGE FORCEPS AND BLUNT DISSECTOR

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THE sponge count has always been a serious responsibility for the surgeon. It was with the idea of controlling this problem that the sponge forceps was devised.

The sponge forceps consists of a detachable sponge made of synthetic sponge material provided with a metal clip which fits with one turn into a holder. The holder consists of two parts, i.e., a clamp and the actual handle. The clamp and handle do not come apart.

Once the sponge is fastened by one turn of the handle it cannot come off. However, one turn of the handle releases the sponge from the holder. It is not necessary to remove the sponge from the holder after it is saturated. The instrument nurse can merely squeeze the sponge in water or in an antiseptic solution, and it is again ready for use.

If the sponge touches a dirty field, the sponge can be discarded by merely rotating the handle and a fresh sponge can be

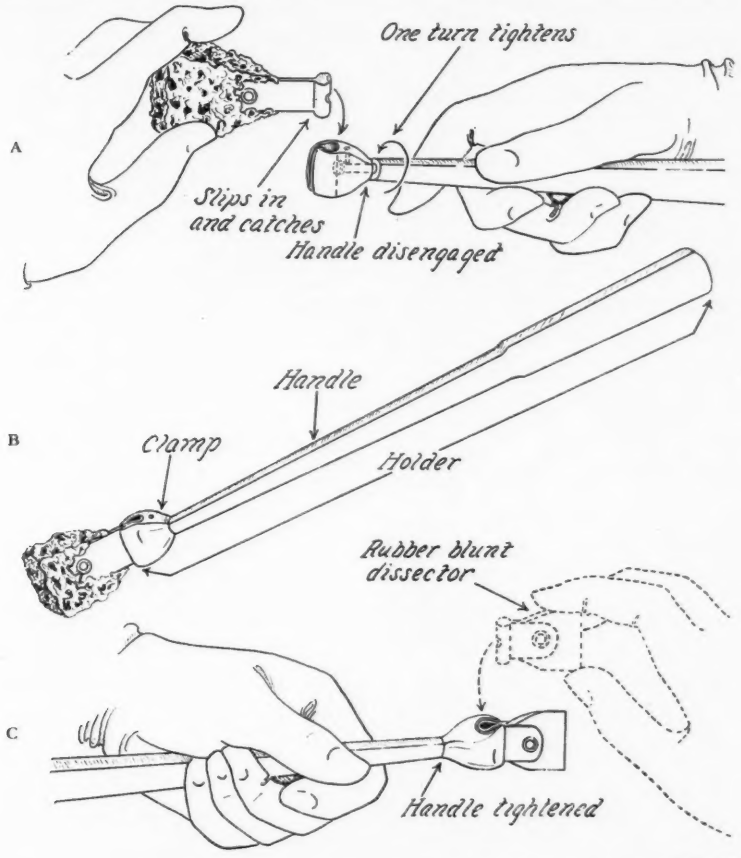

FIG. 1. A, shows the synthetic sponge with clip being fastened in the holder; B, shows the sponge forceps assembled; C, shows the piece of hard rubber with beveled edge attached to clip and fastened in handle for blunt dissection.

inserted. The sponge can be kept in an antiseptic solution during the operation. It can be boiled or autoclaved. Should the sponge ever be lost, the metal clip would show on *x*-ray.

The major part of any operative procedure can be carried out by sponging with this device, although a few large pads may be necessary for packing off.

The holder can be made in various sizes, from a miniature sponge for the most delicate operations, to the largest size for abdominal or vaginal surgery.

The second device is a blunt dissector made of hard rubber fixed in the same metal clip. This can be used in many forms of surgery, such as stripping the bladder from the cervix.

This blunt dissector is interchangeable with the sponge in the holder.

A small tray holding ten sponges, two blunt dissectors and four holders should be sufficient for practically any operation.

The simplicity of this device would have particular value in military surgery.

A DIVERTICULUM which has not given rise to symptoms, but which is discovered during the course of laparotomy for some other lesion, should be excised if the condition of the patient is satisfactory.

Bookshelf Browsing

MEDICOLEGAL PROBLEMS AND ADVANCES MADE IN CONNECTION THEREWITH*

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IT will, obviously, be impossible to discuss all the different advances recently made in all phases of forensic medicine and toxicology. Rather, we must content ourselves with a brief discussion of a few of some of the more important advances recently made in this field that interests us.

HISTORICAL

It has been apparent since the latter part of the eighteenth Century that proper administration of justice depended in no small measure upon the adequate and scientific presentation of medical observations and deductions and that a scientific medical training induces to greater efficiency in the administration of medicolegal affairs. Accordingly, within the short period of about one-quarter of a century most of the European countries established medicolegal institutes, lectureships or professorships on forensic medicine within the confines of their leading universities and, in many cases, the professors or lecturers on legal medicine were actually also governmental officers, or their assistance was sought voluntarily by the Coroners and other criminal investigating authorities. Simultaneously with this development a whole new literature sprang into being with the appearance of numerous textbooks on legal medicine, its various problems and the proper scientific procedure to be followed in each case, etc. In the beginning, the amount of work of a medicolegal nature that had to be done was relatively small but, recently, the great increase in scientific and medical knowledge and the corresponding increase in the number of different kinds of observations of forensic value have greatly increased the amount of work to be done by the Coroner or Medical Examiner. The increased contact between law and medicine, as a result of the government becoming more socially minded, has also greatly increased the amount of work and the number of cases to be investigated yearly by the Coroner's office. While, specialization in medicine usually means limitation of one's field to a restricted part of the whole of medicine and surgery, specialization in forensic medicine means just the opposite. It represents a dispersion of scientific activity and embraces a number of scientifically unrelated enterprises, brought together solely because of their common usefulness to the administration of justice.

MEDICOLEGAL INSTITUTES

These institutes abroad were surveyed in 1928 by the Rockefeller Foundation and in 1939 the American Medicolegal Association again reviewed this important matter. The purposes of the establishment of such an institute (or institutes) in this country would be to develop a true science of legal medicine in the United States and afford

* Read by Coroner David H. Atwater, M.D., before the Annual Convention of the National Association of Coroners, Philadelphia, Pennsylvania, August 20, 1940.

opportunities for both physicians and lawyers to acquire training entitling them to become competent medicolegal experts, and in general to elevate to a higher level the practice of the Coroner's office and of that of the Medical Examiner. Eventually we can look forward to the establishment of such an institute with University connections so that after graduation a degree of Doctor of Legal Medicine, or similar diploma, will be granted much along the line of graduate training now being received by our health officers, after which they become Doctors of Public Health.

BLOOD GROUPING TESTS AS EVIDENCE

Recent scientific findings would seem to substantiate the Land-steiner blood-grouping theory of the inheritability of blood types. This is of great medicolegal importance and the scientific application of this fact to rape, bastardy, property inheritance, paternity, etc., has already been considered in various court actions, and even legislatures are beginning to formulate laws based upon the reliability of these tests. However, it is understood that only tests performed by a well trained physician or scientist (in New York State the Court often picks this physician from a panel drawn up by the State Medical Society) will be allowable as evidence and, besides it is admissible as evidence in court only when it tends to prove in a negative manner, that the individual in question is not the father (or mother) of a particular child. This means that if a woman of Group *A* is admittedly the mother of a child of Group *O*, or *B*, or *OB*, for example and if the alleged father is also of Group *A*, actually he cannot be the father of the child. On the other hand, if the alleged father and mother and the baby are all of one group, the test is inconclusive because a mother of Group *A* can have a child of Group *A* with a man of another group, such as *O* or *B*, as well as with a man of Group *A*. These tests are well worth performing in all indicated cases; unfortunately in some states the courts have believed that they did not have the power to compel individuals to submit to these determinations. In other states, as South Dakota, the court there ruled that it has such power in all cases except those of a criminal nature in which, because of the constitutional privilege against self-incrimination, a compulsory order to submit to a blood grouping test would not be permissible.

THE "LIE DETECTOR" (POLYGRAPH)

This mechanical instrument has recently been developed with the object of helping to determine whether the individual subjected to this test is telling the truth or not. It is based on the assumption that when lying the average person shows more signs of emotion than when he is telling the truth. Ordinarily this may be true, but it depends much upon the patient's personality, education, etc. Hardened criminals will often give a negative test, though lying, whereas a nervous but innocent individual may give a psuedo-positive reaction. In experienced hands, however, this machine undoubtedly has value and in the future, mechanical perfections in the apparatus plus a more skillful handling of the same and a more expert interpretation of its findings may all concur in making this "Lie Detector" of undoubted medicolegal value. As is well known, the apparatus is intended to measure certain definite physiological changes that are assumed to occur while a person is lying. It actually records changes in the heart beat, the capillary circulation, the blood pressure, the respiration and in certain other muscular movements.

The opinion of medicolegal experts on the value of the polygraph varies considerably. Most of them believe the test is not infallible and that only a skilled physician, physiologist or psychiatrist should manipulate the machine. Very few have had actual experience with this machine as yet, although at least two different makes are already on the market. Besides, many authorities are doubtful about whether

evidence obtained by this machine should or should not be admitted in court. Dr. James H. Huddleson, psychiatrist of Portland, Oregon, says: "In an overwhelming per cent of cases, say ninety-five, I would expect the polygraph to be a dependable test of the presence or absence of deceit (of consequence)." . . . "A negative result, however, should not be taken as conclusive evidence that the testee is innocent. We all see persons who are so 'hard boiled' that nothing breaks them down" . . . "the recordings should be admitted as evidence" (but not conclusive evidence, he says). . . . "I think the polygraph does merit the endorsements given it." Lemoyne Snyder, M.D., LL.B., Medical Director, Michigan State Police, says: . . . "in the hands of properly qualified operators the Keeler polygraph and Fordham psychogalvanometer" (both of which instruments, he states, are constantly employed in their laboratory) "have shown a high degree of accuracy and in my opinion their use is a dependable method of detecting deception. In the last four and one-half years we have used the polygraph in over 1300 criminal examinations. While we appreciate its limitations and are fully aware of the possibility of error, up to the present time we have on no occasion found that we have been misled by its findings." . . . "In approximately 75% of our cases where the polygraph has indicated deception, we have obtained a complete confession to the crime. We look forward to the time when possibly the instrument and technique will be so perfected that recordings may be admitted as evidence against the defendant, but it would be a great mistake to attempt this at the present time." And this represents the author's opinion also of the present status of this problem.

ALCOHOL DETERMINATION

Recently, studies have been made concerning the relationships between brain, blood and urine alcohol contents. The brain is acknowledged as the best source but when autopsies are not available the blood can be aspirated directly from the heart using a 20 cc. syringe with a 5 inch long, 17 gauge needle and the urine can be obtained by catherization. Based on a large series of cases, Frank Stratton, chemist of the Boston Police Department, has evolved a series of equations for estimating the brain value of alcohol from either the blood value or the urine value, or both. According to their calculations the blood-brain relationship (based on 200 cases) is:

Per cent alcohol brain
= 0.00 plus 1.00 (per cent alcohol blood)

which really amounts to a 1 to 1 relationship. The urine-brain relationship (based on 100 cases) is:

Per cent alcohol brain = −0.04 per cent
plus 0.84 (per cent alcohol urine).

In combining the above, to obtain a multiple equation for estimating brain per cent alcohol from blood and urine percentages, the following "combined equation" was obtained:

Per cent alcohol brain = −0.03 per cent
plus 0.21 (per cent alcohol urine) plus
0.80 (per cent alcohol blood).

Admittedly, the value of the urine per cent is more debatable than that of blood; however, it is better than no data at all and the use of blood and urine will, in the occasional case, prove more accurate than calculations based solely on the per cent of alcohol present in the blood.

The above methods have practical usefulness only when performed shortly after death and when the material has been properly refrigerated because it has been ascertained lately that in examining putrifying tissues for alcohol percentages, these results are unreliable because after a time they contain an increased per cent of alcohol. Apparently such increase in alcohol per cent is a frequent factor in putrefaction and it is, somehow, related to this process. Stratton found that of fifteen specimens held in their refrigerator room for varying periods of time, eight of them showed an increase in the per cent of alcohol they con-

tained (over their original percentages), said increases varying from 0.02 to more than 0.10 per cent, showing the utter worthlessness of making alcoholic determinations on putrefying materials.

As though it were not sufficient to find out that putrefying tissue can increase their alcoholic content and that postmortem tests for alcoholism on such tissues are no longer of the slightest value we have now also come to learn that even tissues not obviously putrefactive give alcoholic per cent reading when no possibility of alcoholism exists: viz.—"A normal sheep skull, after immersion under cool water for nine days, was tested for ethyl alcohol . . . (using a modification of the method devised by Sydney and Smith. . . . The brain substance was found to contain 0.146 per cent ethyl alcohol." (Cornish, Draper and Finin.) Obviously such an experiment renders the value of postmortem tests for alcoholism exceedingly doubtful even when the postmortem tests are made promptly and on apparently normal brain tissue. The sheep skulls used were purchased of a local butcher who had them for sale as food. The animals had been freshly killed the previous day and the skulls had been kept on ice over night. Although the external skin and tissues had been removed, the skulls used were otherwise intact, each containing skull and brain with its membranes, etc. The chemical explanation has not yet been forthcoming. However, it is known that mammalian tissue, when subjected to damp and anaerobic conditions, often undergoes a peculiar decomposition resulting in the formation of "adipocere." This latter consists of saturated fatty acids formed by hydrolysis and hydrogenation of the body fats, and that it seems plausible that as a result of this change involving hydrolysis and chemical reduction, aliphatic alcohols, and especially ethyl alcohol may be formed.

CHLORIDES IN DROWNING

This new test is of considerable importance although the Coroner or Medical Examiner must not consider it actually a test for drowning. Rather, it is a test for the type of water inhaled if such inhalation has occurred. If the heart blood is badly decomposed, the test will be unreliable; likewise, if any communication exists between the right and left halves of the heart—such as with a patent foramen ovale—the test would obviously be unreliable. It is well known that death by drowning may occur without actual inhalation of water, and in these cases our usual explanation is that a spasm of the glottis occurred and the patient had virtually asphyxiated in the water. But, admittedly in the vast majority of cases, water actually is inhaled and then the percentage of chlorides in the heart blood will vary, because the inhaled water enters the pulmonary venous circulation and goes thence to the left ventricle. The chloride content of the blood in the left ventricle will, therefore, be higher than that of the blood in the right heart if drowning occurred in salt water, whereas it will be lower if the drowning occurred in fresh water. In conducting this test, blood is aspirated separately from the right and left ventricles by the use of two separate syringes with large bore needles. The test is interesting and, on special occasions, it may be very important from a forensic viewpoint.

DETECTION OF BLOOD

One of the most recent and successful methods of testing for evidence of blood (as in suspected cases of blood stains, etc.) is by the fluorescent process known as "chemiluminescence." Recent investigations have shown that 3-aminophthalhydrazide (luminol) is an exceptionally sensitive reagent for hematin. This chemical was first synthetized by A. J. Schmitz from hemimellitic acid but its peculiar property of exhibiting a blue chemiluminescence upon oxidation in an alkaline solution was observed for the first time by Lommel in the I. G. Farbwerke Research Laboratories in Germany. In 1935, Hundress, Stanley and

Parker synthetized this chemical from other sources and named it "luminol." Research experiments indicate that oxidation is not the direct cause of the luminescence since it only produces the azo compound. Then, when once this compound has been formed, the subsequent addition of alkali is followed by the occurrence of the desired luminescence.

W. Specht must be credited with being one of the very first to realize the medicolegal value of the detection of blood stains by the method of chemiluminescence. He demonstrated its value by spraying fences, walls and bushes with blood and then, after a long period of exposure to rain, sun and climatic conditions, he applied luminol to these faded areas of blood stain and obtained such a brilliant fluorescence at night that they were photographed and showed clearly on the photographic plate. Specht found it just as easy to detect bloodstains on the hands, or on any object disposed in sewage, or after treatment by water or even soap and water. In fact, blood could be detected even in the water or the soap and water itself. Other investigators have confirmed these findings and have shown the test to be exceptionally valuable because it renders quickly possible the testing of large areas of suspected material. In fact, Proescher and Moody have detected blood stains on iron pipes, papers and fabrics even three years after their continuous exposure to sunlight and air and they state that three-year old putrefied blood gave an exceptionally brilliant luminescence and that such dried or decomposed blood usually gives a more pronounced and longer fluoroscence than that produced by fresh blood. Stains of fresh blood can be made to render a brighter luminescence if they are first allowed to dry and then sprayed with 1 per cent hydrochloric acid, which produces acid hematin by hydrolyzing the hemoglobin; then, adding the alkaline luminol solution a brilliant chemiluminescence is produced.

Specht used a 0.1 per cent solution of luminol is 5 per cent sodium carbonate with the addition of 15 per cent superoxydol. He also used 0.1 per cent luminol in 100 cc. of a .05 per cent solution of sodium peroxide. It is a yellow amorphous substance that exhibits a yellow-green fluorescence in the presence of ultra-violet light and that dissolves in boiling hydrochloric acid only with considerable difficulty. This acid solution of luminol has no powers of chemiluminescence. On the other hand, luminol is readily soluble in a solution of sodium carbonate and this alkaline solution exhibits a marked bluish chemiluminescence with hematin especially, but also with sodium hypochlorite, potassium, ferricyanide, ammoniacalic copper solution, manganese peroxide and vegetable peroxideses (Proescher and Moody). These latter (vegetable peroxideses) can be destroyed by boiling and the other, inorganic catalizers, as the hypochlorites, manganese peroxide, ferricyanide, etc., do not come into consideration in medicolegal cases and besides their presence can readily be detected by chemical means. No other commonly used materials or substances give chemiluminescence with this test when properly performed.

Of course, this test is positive for all kinds of bloods, animal as well as human. This test is so sensitive that hematin can be detected in a dilution of 1 to 100,000,000. If the test shows the presence of blood, other tests must be conducted for the final identification of the blood, proving the presence or absence of human protein, etc. The use of chemiluminescence as a preliminary test does not in anyway interfere with subsequent investigations by spectroscopic, chemical or precipitation tests, or by other known means. As is well known, the precipitation test can be applied provided the blood is not decomposed and even after repeatedly testing the blood with luminol, hematin and hemochromogen crystals of dried blood were obtainable. The phenomenon of chemiluminescence is readily seen in the dark where it can be photographed with orthochromatic films using an exposure time of one minute or

less. It cannot be denied that chemiluminesence forms a very important advance in recent forensic medicine.

GUNSHOT WOUNDS

In many fatal cases, it becomes important both from the civil as well as the criminal standpoint, to determine at what distance a shot has been fired. When a weapon is discharged close to a target the blast of flame at the muzzle forms the first zone, surrounding the bullet hole. In this zone, the nap of a woolen fabric or human hair will be singed or seared. Outside of this area we have the second zone of smoke and residue. The most peripheral is zone No. 3 and here we expect to find scattered grains of burned and partially burned powder. The word "tattoo" has been coined to describe the appearance of the skin surface surrounding this wound of entrance. It is not generally known by Coroners at present, however, that this "tattoo" appearance varies considerably depending upon whether black powder (now becoming obsolete) or the more recent brand of smokeless powder was used in making the bullet. Concerning this question, Smith and Glaister say: "In the case of black powder, tattooing is, as a rule, distinct, and numbers of blue-black grains are to be seen driven into the skin. These often form minute bluish circles surrounded by a ring of ecchymosis. With smokeless powder, on the other hand, combustion is much more complete, and good tattooing is *not* commonly seen. Occasionally, even at short range, no tattooing is to be seen."

Depending upon the type of smokeless powder used and the distance at which the shot has been fired we may or may not find evidence of tattooing. Often there will be only a light grey residue, which is easily overlooked, and therefore, it is of great forensic importance for the Coroner or Medical Examiner not to jump to the unwarranted conclusion that, because of the absence of tattooing the shot could not possibly have been fired at close range.

MEDICOLEGAL EXAMINATION OF HAIRS

Of recent years many important cases, both civil and criminal in nature, have been decided upon evidence furnished by a few hairs found at the scene of the crime, upon the body of the victim or upon the assailant (who is often a sexual derelict) or upon some object, as a hammer or "hit and run" automobile used by him. It is, therefore, obvious that Coroners and others interested in forensic medicine must be well acquainted with the characteristics of hair which, as is well known, retain these characteristics for centuries. Detailed literature is now available on this problem, including Lambert and Balthazard's treatise and interesting atlases by Fritsch and also by Frienthal, Waldmeyer and Grimm. In addition to the above important German sources, the Coroner can learn much about the procedure to be followed in the medicolegal examination of the hairs by consulting the works of John Glaister, Babcock and Griffith and Henfrey. These latter works are all in English.

Identification of hairs can best be done by one expert in that field and one who is equipped with a collection of hairs of known origin so that he may use them for comparison and thereby be better able to give a correct opinion of the source of the unknown hair being examined. In conducting his examination, the expert will give consideration to the following characteristics: Color, length and breadth, character of hair tip, condition of hair bulb, character of the outer coating or cuticle and of the cortex and medulla of the hair shaft, presence or absence of dye, manner of hair severance, and the morphological appearance of the cross section of the hair shaft or bulb.

Concerning length, the hair of women is usually longer than that of animals, whereas wiry hair is seldom found in humans (except in the beard, moustache or pubic regions). Human hair tips are, characteristically, sharply pointed. Sharply severed hairs will show this characteristic under the microscope, whereas the fiber

bundles appear ragged if they have been severed by a blunt instrument. When hairs have been pulled out a healthy bulb or root is seen, microscopically, although its surrounding sheath is not intact; but where the hairs have fallen out, the microscope will reveal atrophy of the bulb and, usually, absence of its surrounding sheath. Concerning hair dyes, the normal color of the hair near the root may be seen; the hair dyes can often be easily detected under filtered ultra-violet light, and the nature of many hues can be ascertained by appropriate chemical tests. Characteristic appearances are also present under microscopical examination.

In the medicolegal examination of hairs the Coroner usually wishes to learn whether the hairs are human or not, and if so, from what part of the body they were derived and what is the probable sex and age of the individual who possessed the tested hairs. Having ascertained by comparison with his collection of hairs, as well as by definite microscopical characteristics, that the hairs to be tested are of human origin, the Coroner or medicolegal expert will remember that the hair on the male scalp is usually stouter, shorter and more wiry than that on the female scalp and that the stiff hairs of the male beard and moustache are much firmer and less curly than the female pubic hair (with which it might be confused) and that the male eyebrow hairs are longer and stiffer than those usually obtained from female sources. It is very hard, also, to be absolutely sure of the age of the individual whose hairs are examined. However, in children the hairs are very soft and deficient in pigment and, often, also deficient in medulla. Hair obtained from elderly individuals is apt to be greyish and, microscopically, degenerative changes are seen in the bulb and shaft together with pigment absorption. The medulla shows loss of its cellular substance and may appear as a simple, thin line. The atrophied bulb is also very characteristic of advanced age. Of course, even young individuals may possess hair showing degenerative changes, but here the cause is due to the fact that said hair is the seat of some disease, as alopecia areata.

SPECTROSCOPIC METHODS FOR DETECTION OF VARIOUS OBJECTS

It frequently occurs in many medicolegal investigations that very little material is available for either conducting a satisfactory chemical examination or to apply the ordinary tests. This forsenic problem is now met with successfully through the science of spectroscopy which has in recent times made great advances, and has been found to be of especial value in just such circumstances.

The use to which the spectroscope may be put are many: For example, it may be used in the examination of the residues of gunpowder found about the surface of a wound or in examining the traces from the interior of the barrel of a weapon which was allegedly used in a particular case. Another good advantage to which spectroscopy may be used is in detecting mercury stains especially when discharged at close range from the fulminate in the percussion cap. Similarly where no projectile is found in the body or the wound on the body is not characteristic of a gunshot injury, a spectroscopic examination may be made of pieces of tissue in the edges of the wound or of the surrounding clothing to determine whether or not the passage of a metallic body has occurred. This spectroscopic method is also of great value to ascertain impurities of a particular nature in a metal, such as when we may seek information as to whether the projectile which may be found on the body of the victim or at the locus of the crime, is of the same or identical composition to that which may be found on a suspected person. In such cases, if both bullets contain the same identical metallic imperfections, it is reasonable to assume that they were derived from a common source. Rarely, error may occur because of the highly sensitive nature of this procedure. In the average case, examination by the quartz spectrograph is the preferable

procedure because then not only can the spectrum be viewed by the investigator, but it can also be photographed and presented in court as evidence, when necessary.

Sometimes chemical investigations fail to detect traces of metal or unsuspecting elements and at all times these chemical tests are apt to be long and troublesome. But in spectroscopic analysis there is certainty of detection because the whole substance is disintegrated into its elements under the powerful influences of the arc or spark, thus enabling each element to emit spectra from which it can be identified.

Modern spectrography is not limited to spectra perceived as light only. The quartz spectrograph has the ability to photograph ultra-violet spectra also; and it will be remembered that many substances which do not give a satisfactory spectra in the range of visible light do, nevertheless, give a highly satisfactory one in the ultra-violet field, thus enabling the examiner to detect their presence by means of these clearly defined lines in the ultra-violet. The modern spectroscope is capable of detecting any metal and also certain important non-metals, such as phosphorus, boron, arsenic and silicon.

Recently, spectrography has been applied by Dobbie and others in the examination of organic substances by means of their absorption spectra. These investigators claim that alkaloids and glucosides, as well as other organic substances, exhibit a characteristic absorption curve, which is useful in detecting the nature of the substance being examined.

Messrs. Boyle and Amy, through their investigations for metal tracing along the course traversed by the projectile were easily able to detect lead, but in addition, and this is rather of recent interest, they were also able to detect the presence of copper in the cloth around the edges of bullet holes. They also swabbed the interior of the gun barrel with moist cotton-wool and upon examination of this residue from the barrel they were able to detect zinc and nickel. Other investigators have also found that this method may be successfully used for the examination and the detection of powder residues.

Recent investigators have found other instances in which spectroscopic methods may be of value, as in the examination of inks, in the search for traces of paint, in the examination of bleached texts, and in the examination of erased texts, if said erasure was produced by the use of potassium permanganate. Obviously, spectroscopy presents a large, important and relatively virgin field for new developments for the Coroner and medicolegal expert.

IDENTIFICATION OF UNKNOWN BODIES

According to the records of the F. B. I. from January to November, 1938, a total of 16,141 persons were reported as missing throughout the United States, and of this number at least 1,254 were proven dead, since that number of unknown bodies had been found. However, and this is the preventable and regrettable part, only 400 of these 1,254 unknown dead have been identified. Surely, universal fingerprinting could have made possible the identification of the remaining bodies. The benefits of universal fingerprinting, greatly augmented in importance now by wars and crises, are so obvious that in a recent Gallup poll, 71 per cent of the replies were favorable to a universal fingerprinting of all persons residing in this country. In this connection, Dr. David H. Atwater, Coroner, of Rochester, New York, had an interesting case that was fingerprinted and identified by means of *x*-ray studies: An unknown body was found after having been imprisoned in a refrigerator box car for some two months. Identification by taking fingerprints in the usual manner was impossible because of the advanced stage of decomposition present. Accordingly, the fingerprint surfaces were impregnated with pulverized lead residue which filled all the skin crevices, the finger tips were then cut off from their respective fingers and *x*-rayed by a portable apparatus brought to the morgue by the Eastman Kodak Company. This proce-

dure successfully resulted in obtaining an accurate reconstruction of the original fingerprints, identification was rendered possible and the unknown was found to be a veteran of the United States Regular Army.

CONCLUSION

The author regrets that space will not permit a discussion of additional medicolegal advances of recent date. It is his opinion that Dr. Atwater's case of reconstruction of fingerprints marks a definite and substantial contribution to forensic medicine and will prove of permanent value.

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Intussusception is the telescoping of one portion of the intestine or colon into a more distal segment of the enteric tube. When an intussusception has been drawn into its intussuscipiens, the process is almost invariably a progressive one until death supervenes or operative relief is afforded.

The brief excerpts in this issue have been taken from "Abdominal Surgery of Infancy and Childhood" by William F. Ladd and Robert E. Gross (W. B. Saunders Company).

CONQUERORS OF YELLOW FEVER

by Dean Cornwell, N.A.

"CONQUERORS OF YELLOW FEVER"

"CONQUERORS of Yellow Fever," the third in the series of paintings called "Pioneers of American Medicine" by Dean Cornwell, was unveiled before a group of distinguished physicians in Cleveland on June 2, 1941, and shows Major Walter Reed, head of the United States Special Yellow Fever Board on the steps of the Officers' Quarters at Camp Columbia, Cuba.

Dr. Carlos Finlay was a Cuban physician and had propounded the theory that the yellow fever mosquito is responsible for transmitting the disease for nineteen years before the beginning of Dr. Walter Reed's work. But Finlay could not prove his theory to the satisfaction of the medical profession.

While Carroll, shown in the painting receiving the bite of an infected mosquito, was the first to become ill as a result of experimental work, Dr. Lazear was the first man to die of a self-inflicted mosquito bite. Privates Moran and Kissinger, shown at the extreme right of the painting, were the first two volunteers to submit to inoculations after the mosquito theory was believed by the Yellow Fever Board. Moran still lives in Cuba and John R. Kissinger was present at the unveiling of this painting in Cleveland. All the members of the special Yellow Fever Board are dead. The widow of Major Walter Reed, an elderly woman of eighty-five, still lives at Blue Ridge Summit, Pennsylvania. Major Reed's daughter, Miss Blossom Reed, performed the unveiling ceremony in Cleveland.

Reed's greatness lies in the fact that he planned and carried out a series of controlled experiments which proved without the slightest doubt that Finlay had been right. As a result the Panama Canal and its maintenance became possible.

Selected Book Review

TEXTBOOK OF GENERAL SURGERY*

By Warren H. Cole, M.D., F.A.C.S. and Robert Elman, M.D.

THERE are several worth while works on general surgery at the present time but we believe that none of them is more adequate or satisfying than the thoroughly revised and reset

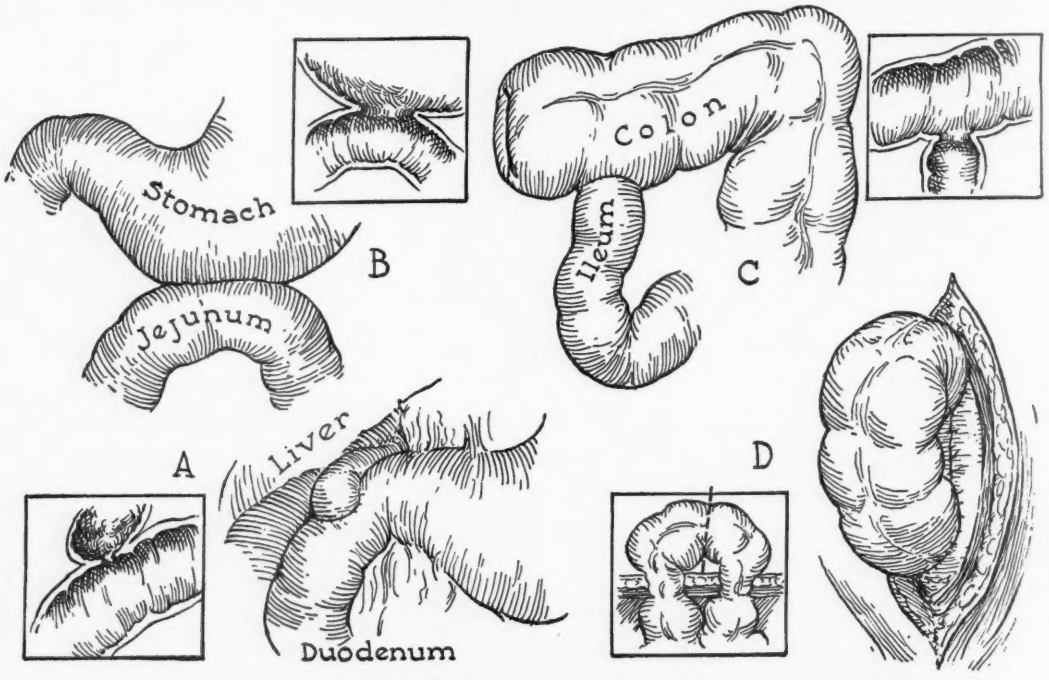

Fig. 1. Common types of intestinal fistula produced by operative means. *A*, cholecystoduodenostomy, performed usually for carcinoma of the pancreas or inoperable carcinoma of the ampulla of Vater; *B*, gastrojejunostomy, utilized in stenosis of the pylorus or duodenum; *C*, ileocolostomy, commonly performed in resection of the proximal colon for carcinoma; *D*, double-barrelled colostomy, as performed to correct obstruction in inoperable carcinoma of the rectum, or in the Lockhart-Mummery type of resection of the rectum for carcinoma. On the second or third day the sigmoid is cut across, as shown by the dotted line in the insert. (Fig. 85, in Cole and Elman's "Textbook of General Surgery," D. Appleton-Century Company, Inc.)

third edition of Cole and Elman's "Textbook of General Surgery." We have gone through it with care and offer no adverse criticism; it

* New York, 1941. D. Appleton-Century Company, Inc.

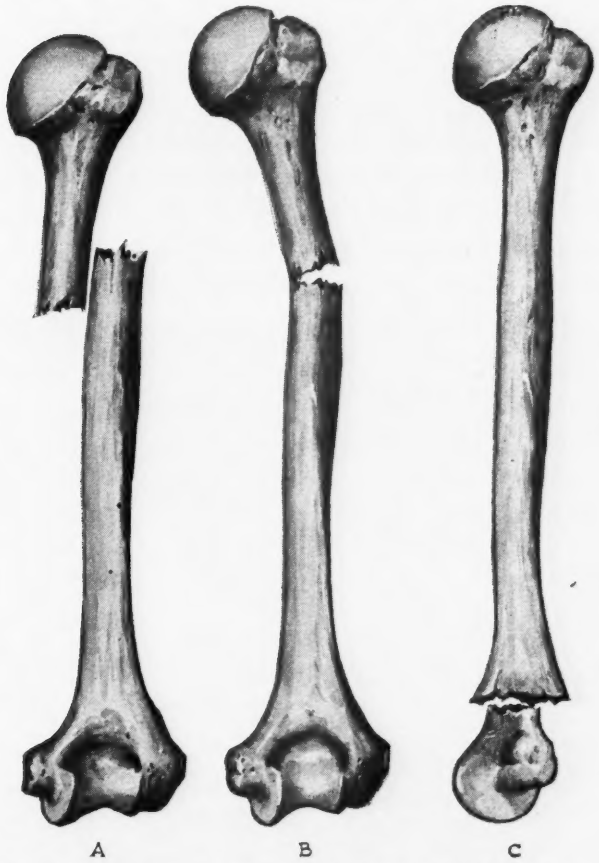

FIG. 2. Three general types of deformity which may be produced by fracture. *A*, displacement with overriding of fragments. *B*, angulation. *C*, rotation. The deformity of rotation can be shown in the *x*-ray only if the entire bone is shown, *e.g.*, the proximal end of the humerus as shown above represents an anteroposterior view, whereas the distal end is rotated 90° to a lateral view. (Fig. 208, in Cole and Elman's "Textbook of General Surgery," D. Appleton-Century Company, Inc.)

is in every detail what a textbook should be. The writers were fortunate to secure the active collaboration of the following specialists:

Willard M. Allen, St. Louis (Gynecology)
Alfred Blalock, Baltimore (Shock)
Alfred Brunschwig, Chicago (Neoplasms and Cysts)
William Cassels, Chicago (Anesthesia)
F. A. Coller, Ann Arbor (Peritoneal Cavity)
Evarts Graham and Brian Blades, St. Louis (Thoracic Surgery)
R. A. Griswold, Louisville (Fractures)
Charles G. Johnson, Detroit (Intestinal Obstruction)
J. Albert Key, St. Louis (Organs of Movement)
Cyril M. MacBryde, St. Louis (Endocrines)

John Mulholland, New York (Vascular System)
Howard Naffziger, San Francisco (Nervous System)
Thomas G. Orr, Kansas City (Amputations)
D. K. Rose, St. Louis (Urology)
Harvey B. Stone, Baltimore (Alimentary Tract)
Ralph Waters, Madison, Wisconsin (Anesthesia)
Allen O. Whipple, New York (Liver, Gallbladder, Pancreas and Spleen)

When one reads the text he is impressed with the fact that these outstanding gentlemen in their various fields were not used for

FIG. 3. Carcinoma of the breast in a forty-year-old woman. Note the retraction of the nipple and the dimpling of skin (orange-peel appearance) induced by relaxing the skin over the tumor. Note also the pitting edema. A tumor of the breast was first noticed four months previously but grew rapidly followed daily massage of the lump, a procedure which was recommended to the patient by an irregular practitioner. A radical breast amputation was performed; parts of the block dissection are also represented. In the upper specimen are shown the strands of tumor attached to and retracting the nipple (N) and also includes part of the resected pectoral muscle; the lower specimen is a part of the axillary contents and shows tumor tissue replacing the axillary lymph nodes surrounding a small vein. (Fig. 484, in Cole and Elman's "Textbook of General Surgery," D. Appleton-Century Company, Inc.)

window-dressing purposes but they actually put in many hours of careful, painstaking work. In the past five years (the first edition appeared in 1936) a great many advances in surgery have been made.

This work is up to the minute, the last word at the present time. Detailed considerations of such specialities as ophthalmology, otology and rhinology have been eliminated purposely. The authors, however, devote separate chapters to such allied specialities as genitourinary surgery and gynecology. Certain details of neurosurgery are presented, particularly in regard to head injuries. Particular attention is given to open wounds and burns. Many changes and additions have been made in the treatment of fractures, especially compound fractures. These are opportune because of the present times and war emergencies. The chapters on amputations and on anesthesia have been enlarged; a new chapter on diabetes has been included, and the use of sulfonamide in surgical conditions, especially accidental wounds and abdominal operations, has required extensive additions. Water and electrolyte balance as well as transfusion and the use of plasma are thoroughly discussed, and present day knowledge of the endocrines is offered in detail. The chapters follow a logical teaching sequence.

The illustrations are excellent. In this edition about fifty illustrations have been changed completely or improved, and the text matter has been increased fully 15 per cent. A bibliography, for those who desire to extend their studies or reading, is listed at the end of each chapter. The index has been remade and enlarged.

The work is well written and edited. Both authors and publishers are to be congratulated in offering this modern, timely and authoritative work on general surgery to the profession at large and to students of medicine in medical schools.

SPECIAL MONOGRAPH

COMPRESSION OF CANCELLOUS BONE

Principal Manifestations in the Head and Neck of the Femur Treatment by Connecting Drill Channels

BY

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TABLE OF CONTENTS

PAGE

INTRODUCTION 541
EARLY RESEARCH 542
- Interstitial Absorption, B. Bell 544
- Congenital Limping, B. Palletta 547
- The Sandiforts 550
- Gulliver, Canton, Quain 551
- Malum Senile Coxae. R. W. Smith 553
- Juxta-epiphyseal Sprain, Ollier 555
- Neuroses of the Hip, Fricke, Brodie, Paget 555
- Wernher, Gibney 556
- American Contributions, Richardson, Monks 557
- Hamilton 558
- Arthritis Deformans Juvenilis, Maydl 560

COMPRESSION OF CANCELLOUS BONE 561
INDIVIDUAL MANIFESTATIONS
- In the Femoral Head:
  - Osteochodritis Dissecans 564
  - Waldenstroem-Legg-Calve-Perthes' Disease 565
- In the Femoral Neck:
  - Subcapital Wedge 567
  - Coxa Vara Congenita 567
  - Juvenile Fractures of the Femoral Neck, R. Whitman . 567
  - Hinge Fracture, Taylor 567

COMPRESSION OF THE ACETABULUM 567
COMPRESSION OF THE PELVIC GIRDLE 568
ARTHRITIS DEFORMANS OF THE HIP 569
CONDENSING OSTEITIS OF THE ILIUM, BARSONY 571
ADOLESCENT SACROILIAC SYNDROME, ROGERS 571
COMPRESSION OF CANCELLOUS BONE ACCOMPANYING FRACTURES 572
SEQUELAE OF COMPRESSION 572
FORCE 575
NECROTIC FOCI IN THE FEMORAL HEAD AFTER TRAUMATIC DISLOCATIONS OF THE HIP AND FRACTURES OF THE FEMORAL NECK 576
TREATMENT 577
CASE REPORTS 579
COMPRESSION OF CORTICAL BONE, BLAISDELL, LOOSER, WALTER 612
RÉSUMÉ 613
ACKNOWLEDGMENTS 613
REFERENCES 613

COMPRESSION OF CANCELLOUS BONE*

PRINCIPAL MANIFESTATIONS IN THE HEAD AND NECK OF THE FEMUR

TREATMENT BY CONNECTING DRILL CHANNELS

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DURING the last fifty years a group of pathological changes, involving the head and neck of the femur in the growing child and adolescent, has become increasingly noted.

With the advent of roentgenography the groping progress of differentiation within this group assumed a more vigorous stride. On correlated clinical and radiographic, and in lesser measure histological evidence, this group soon became sharply outlined against other diseases occurring in the hip.

Emerging, as the author traces them, out of the collective vagueness of "interstitial absorption" (B. Bell,[11] 1824) and "nervous coxalgia" (Brodie,[21] 1837, Paget,[81] 1875), this group today comprises the following diseases as accepted entities:

Osteochondritis dissecans of the head of the femur, the several forms of coxa vara, the Waldenstroem-Legg-Calvé-Perthes' disease, the slowly slipping, and the acutely slipped, upper femoral epiphysis and the deforming process subsequent to congenital dislocation of the hip.

Concurrently with the mentioned manifestations in the femoral head, changes were observed in the acetabulum, or rather the bones that form this and the pelvis, and "osteochondritis of the acetabulum" (Fromme,[45] 1920) and "acetabular Perthes' disease" (Gaugele,[46] 1931), "ischio-pubic osteochondritis" (Van Neck,[110] 1924), "osteochondritis of the symphysis" (Burman,[24] 1937) and

* Read in parts at the Clinical Conference of the Surgical Services, Morrisania City Hospital, New York, November 26, 1930; Orthopedic Departmental Conference, Hospital for Joint Diseases, New York, January 20, 1932; The New England Medical Center, Boston, March 14, 1939; The New York Academy of Medicine, Section of Orthopedics, May 19, 1939; Clinical Society, Beverly Hospital, Beverly, Massachusetts, June 16, 1939.

"adolescent sacroiliac syndrome" (Rogers,[95] 1935) were added to the list.

Due to similarities of features with the separation of the upper femoral epiphysis, but mostly due to obscurity of nature, the juvenile fractures of the femoral neck were drawn into this group under investigation.

The author believes that all these conditions with some others occurring in different parts of the body, and at present not thought related, are based on one single pathogenetic element, and he shall endeavor to evolve a concept of the same which, if given the key position it merits, shall clear the prevailing confusion and shall facilitate the understanding of the grosser features of the whole group.

Further, a therapeutic principle arising out of this concept will be outlined and illustrated.

The prevailing opinion, as expressed in current literature, allocates the origins of our knowledge of this group, with the exception of osteochondritis dissecans, at the earliest to E. Mueller[79] (1888), or Fiorani[42] (1881), and that of the most puzzling of them to Waldenstroem[113] (1909) and Legg[68] (1910).*

EARLY RESEARCH

Bibliographic investigations of the author, however, led him to uncover material that demonstrates that the recognition and accurate description of some of the important forms of these diseases date back as far as 1785 and earlier, and that most of these conditions were subsequently often encountered and described, and that B. Bell[11] in 1824, and Ollier[80] in 1881 formulated strikingly correct concepts concerning the underlying process.

These concepts, especially that of Bell, were readily accepted by their contemporaries, and were progressing in what the author believes to be the right direction, when they were suddenly sidetracked by the sensational appearance of coxa vara in 1888.

The products of this medical research, which spread over almost a century, are little if at all known. Their noteworthy contents deserve detailed analysis, but in this paper they will be discussed

* Omitting at this time such precursors as Sindig-Larsen, Koehler, G. Schmidt, Frangenheim, etc., and in general writers on juvenile arthritis deformans from Maydl to Perthes.

only in a measure necessary to render an account of the concepts they represent, and to substantiate the claims made before.

During this period under consideration scientific research consisted mainly of correlating clinical observations with the gross pathological specimen. These specimens in the field of bone pathology were furnished in England in substantial numbers by poorhouses and community hospitals that sheltered and cared for the aged and the pauper.

It is in the nature of such a group of patients that, if some among them had suffered earlier in life from any of the conditions of the hip we are concerned with, their autopsy decades later would show far advanced or end stages of these diseases. This latter circumstance introduced an additional confusing element into this complicated matter, namely, that of the intracapsular fracture of the neck of the femur.

It is easy to see that a hip which underwent in childhood or adolescence some of the diseases enumerated, may present at advanced age a strikingly similar picture to that of an intracapsular fracture of the neck of the femur, that by chance resulted in bony union with more or less shortening of the neck.

It was, however, from this overlapping of the two groups that a slow clarification began of the problems involved; for it became increasingly evident that intracapsular fractures of the neck of the femur treated by contemporary methods seldom, if ever, progressed to bony union (Cooper,[29] 1819) and consequently those specimens that showed what was claimed to be bony union of fractured femoral necks, must have been the product of some "morbid action" (B. Bell,[11] 1824) or "altered state" (Cooper,[30] 1825).

Cooper and his collaborators collected an impressive number of cases of fractured femoral necks that were observed through varying lengths of time from accident to autopsy, and have gradually driven home, over English (Earle, etc.) and French (Dupuytren, Desault, Roux, etc.) opposition the tenet of nonunion that was to hold sway until Whitman[121] (1902).

The more this became accepted, the more critical attention became concentrated upon those specimens which were offered as examples of bony union. The few older specimens available for inspection such as that of Trioen[108] (1743), were declared erroneously judged, and based on a large amount of material, B. Bell[11] formu-

lated his conception of "Interstitial Absorption of the Neck of the Thigh-Bone," which after years of oral teaching was published in 1824.

According to this concept: "In an advanced period of life, some-

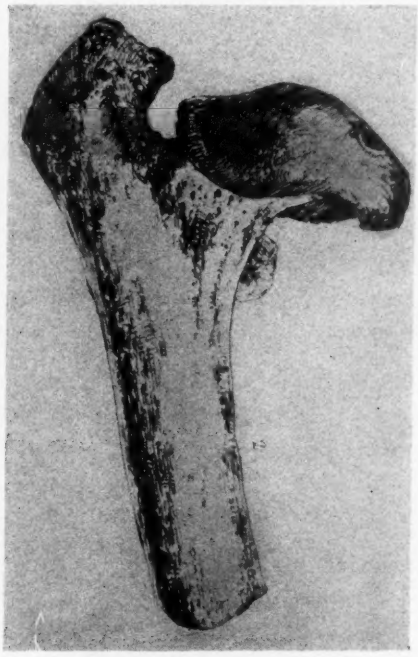


FIG. 1. Bell's illustration of "interstitial absorption of the neck of the thigh-bone" 1824.

thing resembling a yielding or bending of the neck of the [thigh] bone may be perceived. This effect does not proceed from any softening or alteration in the intimate texture of the bone but arises in consequence of the absorption and disappearance of a portion of its entire substance. Sometimes, more than two-thirds of the neck of the bone disappearing, so that the head of the bone is as if it were forced in the direction of its axis towards the base of the trochanter major. In some rare cases (Fig. 1) combined with the shortening of cervix femoris, there is also a flattening of the head of the bone. Superadded [to these changes] . . . frequently the lower part of the neck of the bone [is] seemingly incased in a sheath of osseous matter. It is these cases (Trioen) [Fig. 2] that are apt to be confounded with fractures of the neck of the thigh-bone.

"This affection, incidental to the neck of the thigh-bone, I [Bell] termed interstitial absorption.

"This is a disease of frequent occurrence, but nevertheless has been almost overlooked by systematic writers, or confounded by them with fracture, dislocation, mollities ossium, and scrofulous affections of the hip-joint.

FIG. 2. Supposed bony union of an intracapsular fracture of the neck of the femur, Trioen, 1743. Interpreted as "interstitial absorption" by Bell.

"It rarely occurs in conjunction with rickets—it is a purely local affection, and does not involve much constitutional irritation—and differs from inflammatory and scrofulous affections occurring in the hip-joint."

When first formulated this concept of Bell's seems to have been more or less a corollary to the much discussed topic of the day, to Cooper's thesis of the prevalence of nonunion of fractured femoral

necks. It gave support to this by finding an explanation of those cases that were offered as instances of bony union.

In retrospect it may be said that Bell in his first publication

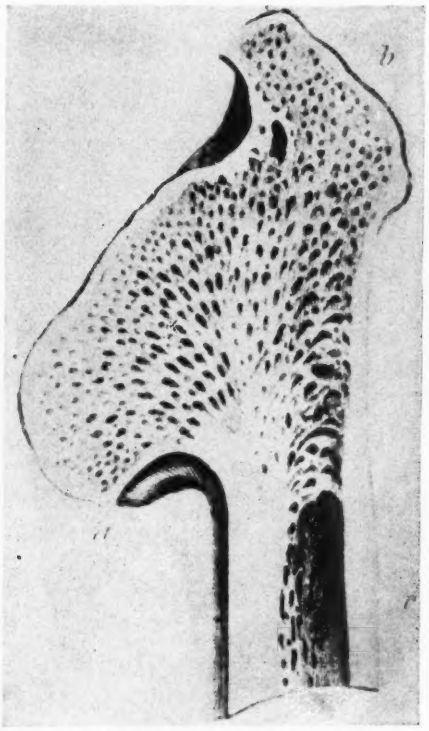


FIG. 3. Cooper's illustration of an extreme case of interstitial absorption, 1825.

described essentially, as the author sees it, the clinical picture of the incomplete or fissure fracture of the neck of the femur that progresses to absorption of the neck and subsequent deformity; a clinical picture which even today is by far not as well known or appreciated as it deserves in spite of the fact that it was introduced into American literature by Hamilton[51] in 1860.

Soon, however, the material of Bell and his followers passed beyond the narrow limits of this one entity, and four years after his first publication, Bell had to enlarge the frame of his concept.

The changes that he believed to be incidental to old age in the meantime, were observed at autopsies of persons other than aged.

"I [Bell] have met with cases since the publication of my memoire on this disease, in which interstitial absorption affected the neck of the thigh-bone of one side in persons of thirteen, thirty, and forty

years of age—and my friend Dr. Knox[62] has related a most interesting and curious example of this affection occurring in the neck of the thigh-bone of a child three years of age."

Further observations of Bell have made him not only extend the age limit of this "interstitial absorption," but also to recognize that the same process may occur in other parts of the skeleton than the neck of the femur, and he intimated the entity which, later outlined if somewhat vaguely by Stanley,[104] Russell[96] and McNamara,[74] eventually became known as Kuemmel's disease of the spine.

One glance at the illustrations given by Bell or Cooper (Fig. 3) or at the case history and autopsy report of Knox is convincing enough to show that what they had before them were instances of the disease or diseases that are the subject of this paper, diseases which today more than a century after these authors' first efforts still lack a satisfactory explanation.

But even they were not the first ones to observe, describe and illustrate these conditions and to formulate an opinion about their nature. Following a reference given by Bell, the author has come upon a work of Giovanni Baptista Palletta[82] who in a monograph in 1785 entitled "On Congenital Limping" (De Claudicatio Congenita), has given a remarkable clinical and pathological description of certain forms of coxa vara and some related conditions with little admixture of other confusing matter.

The work that antedates E. Mueller[79] by more than a hundred years is practically unknown or grossly misinterpreted. Writing ninety-six years after Palletta, his compatriot Fiorani,[42] for whom credit was lately claimed for the description of coxa vara in preference to Mueller, makes no mention of him.

The author considers this work of Palletta as the earliest classic on the conditions dealt with in this paper. It may well be a satisfactory starting point as Palletta, in order to avoid the accusation of indulging in "inane speculations" confirms his statements by autopsy reports and gives an engraved illustration of his most important case. (Fig. 4.) Palletta hands the concept of coxa vara chronologically still farther back to Morgagni, his one-time teacher, whom he credits with the establishment of the fact that shortness and transverse position of the femoral neck may reduce the total length of the limb and cause limping. He gives full description of the autopsy reports of Morgagni's cases, then shows that these findings in the aged, recorded by Morgagni, may also be found in

young persons. He explains these cases due to the absence of manifest pathological changes as congenital malformations and creates the entity of "congenital limping," the first recorder of which he professes to be.

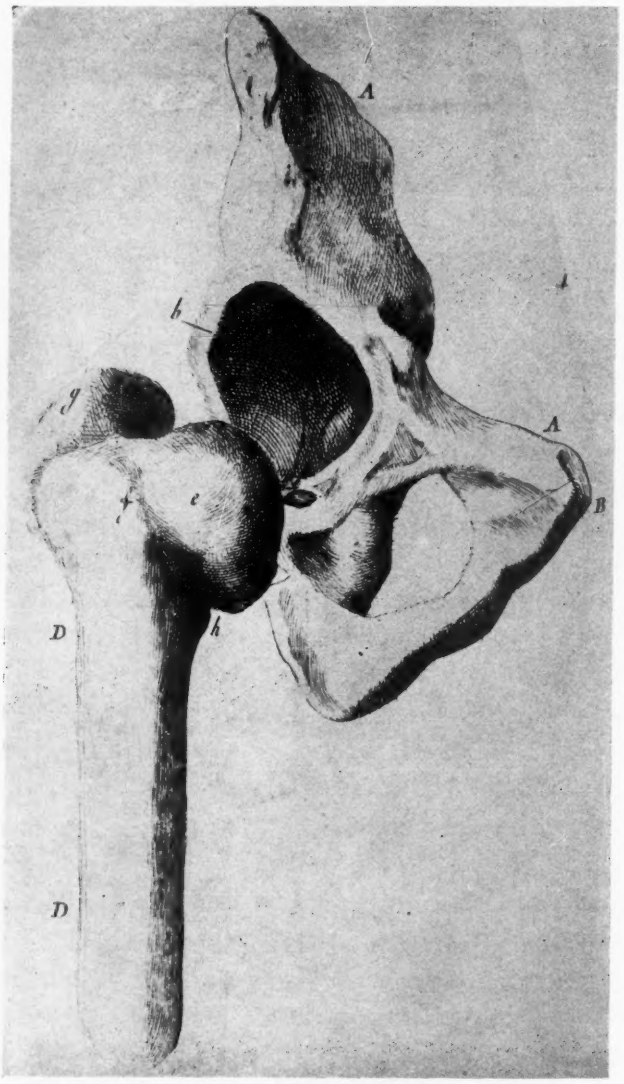


FIG. 4. Palletta's specimen of coxa vara, 1785.

According to Palletta these changes may assume the following characteristics: (1) Shortness to total consumption of the femoral neck; (2) decrease of the neck-shaft angle to right angle and less; (3) subsequent to these changes, lowering of the head below the level of the apex of the greater trochanter and the shaft; (4) en-

largement of the head and also of the acetabulum; (5) oval or flattened deformity of the head with occasional mushrooming of the head over the neck; (6) torsion of the neck anteriorly relative to the shaft; and (7) torsion of the head backward on and relative to the neck.

Aside from these specific findings he emphasizes the generally normal appearance of the joint, the normal aspect of the synovial fluid, the absence of gross alterations of bone and cartilage, no indication of injury; in short, no pathologic findings except the deformity.

The clinical picture Palletta gives is equally as clear, mentioning: (1) Shortening of the limb; (2) flattened buttocks with up and outward curving of the gluteal fold; (3) high stand and lateral prominence of the greater trochanter; (4) absence of marked weakness or wasting of the limb; (5) absence of pain; (6) marked freedom of motion in the joint; (7) emphasizes that it indicates no affection of general health, no lessening of pelvic space (caliber) and no interference with normal parturition.

Claiming credit for Palletta, it must be stated that similar findings were made before him and specimens were kept as curiosities in many collections. Palletta himself mentions the Hovianus Collection of Andreas Bonn[15] with several well described specimens. A study, however, of Palletta's monograph will doubtless prove that he was the first who clearly correlated the clinical features in the living with autopsy findings, and consciously outlined an entity which had to be rediscovered laboriously after his own work was long forgotten.

This oblivion is a bibliographic curiosity. Thirty-five years after his work on congenital limping Palletta, in 1820, published observations on congenital dislocations of the hip antedating Dupuytren[36] by six years. Soon the commentators with rare exceptions (Ammon[2]), misled perhaps by the title of congenital limping, confused the earlier work of Palletta with his later one. Finally, as the author found it, Carnochan,[28] in 1850, prominently featured and firmly established this error by extensive but misinterpreted quotations.

Palletta's contemporaries did not fail to recognize the importance of his work. It was soon translated into German (Tabor, Heidelberg, 1791). In Holland it was reprinted in its original Latin and Palletta's most important specimen with its case history was incorporated into the monumental work of the great anatomist-atlas-makers,

Eduard and Gerard Sandifort,[98] in 1793–1835. It was through this atlas that the case came to the notice of Bell who reprinted it in full and interpreted it as juvenile occurrence of interstitial absorption.

For the Sandifort atlas new drawings were made of Palletta's

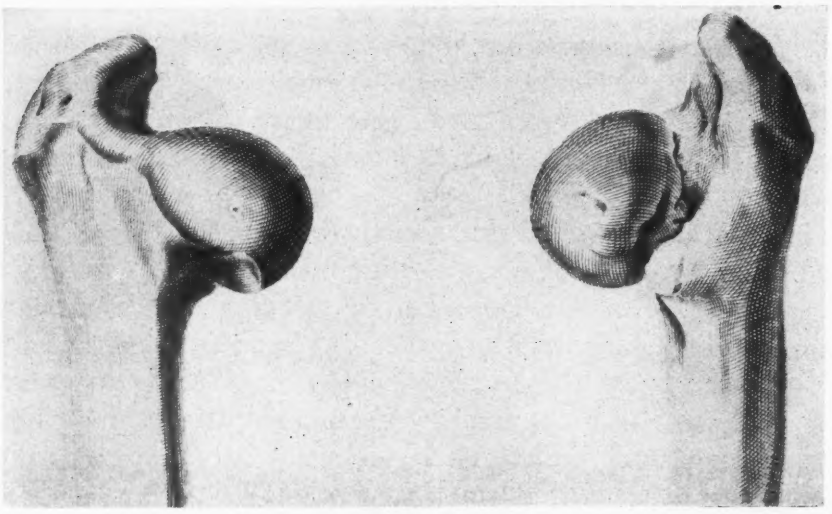


FIG. 5. Palletta's specimen as reproduced in the Sandifort Atlas, 1793–1835.

specimen. These drawings (for this time there are both an anterior and posterior view) are far superior to Palletta's original engravings, and make it possible to identify Palletta's case as that of the late stage of slipping femoral epiphysis. (Fig. 5.)

The two sets of illustrations, while similar enough, differ in detail quite a bit; but it was possible to establish their identity through the statements in the atlas, the works of Paletta, Bell, and E. C. A. Sandifort,[91] the son and grandson, respectively, of the atlas makers, who in 1834 in a monograph on "Congenital Pathological Conditions of the Hip," restates and elaborates Palletta's concept.

These authors, the Sandiforts and Bell, clearly recognized the portent of Palletta's findings. In Holland, through the efforts of the Sandiforts, this disease became well known and was kept apart from the congenital dislocation of the hip. Bell sensed its relationship to interstitial absorption observed in elderly persons. In Germany, thanks to Ammon's[2] faithful following of E. C. A. Sandifort's monograph, this disease became clearly outlined and illustrated (1842). Thus, the early entry of this clinical picture was equally as forceful as its reappearance one hundred years later as coxa vara at the hand of E. Mueller.[79]

In view of this widespread recognition it is strange that all these efforts became forgotten. The more so as in England, following directly upon Bell's work, a group of investigators brought the knowledge of these conditions to a marked degree of development.

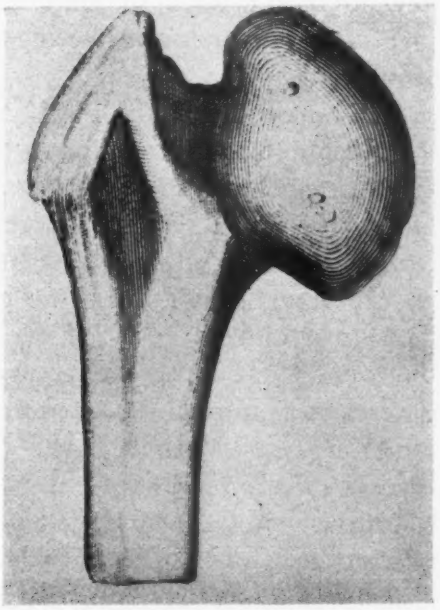


FIG. 6. Gulliver's illustration of "interstitial absorption" in a nineteen year old recruit, 1836.

The first among them was Gulliver[48,49] who in 1836 in two publications stressed the need of clarifying "how far interstitial absorption and shortening of the neck of the femur may be the effect of disease at an early period of life," described several such instances and illustrated one occurring in a "stout recruit" at the age of nineteen. (Fig. 6.)

Knox,[63] in 1843, reports the autopsy findings of yet another juvenile case of shortened femoral neck, and recalling his case referred to by Bell, brings forth the congenital theory of the deformity as his own, apparently not knowing of Palletta.

Canton, in 1848, in a paper,[26] and in 1855 in a monograph[27] consolidates the advances made by Bell, Gulliver, and Knox, and adds to it the clear differentiation of interstitial absorption from tuberculosis of the hip, the "morbus coxarius" of his day—"this latter complaint [morbus coxarius] leading not infrequently to total disorganization of the joint and ankylosis, or terminating in death;

the former [interstitial absorption] being an affection unconnected except incidentally with the strumous diathesis, and ending in loss of the cervix femoris without producing any constitutional disturbance, without the establishment of ulcerative absorption, the formation of matter, involving to a variable extent the head of the bone and the acetabulum, but not affecting eventually to any degree the range of motion."

Proceeding beyond the clinical recording, Canton arrives at a concept which in the opinion of the author is essentially correct: "Where the head and the neck of the femur . . . suffer concussion only . . . where indeed these parts are submitted to a momentary compressing force, passing between the trochanter and the opposite point of resistance, the acetabulum, the same change [interstitial absorption] is liable to take place."

All this Canton rounds out with the recognition that injury to the ligamentum teres may impair the circulation in the femoral head. This is a point on which, however, the youngest Sandifort and Palletta himself have made abundant observations.

The writings of Gulliver and Canton picture the positive progress of knowledge of the shortening of the femoral neck and the lessening of its angle. Reading them, one wonders why, in spite of these observations and this intimate acquaintance with these deformities, orthopedic surgery had to wait for E. Mueller to introduce the concept of coxa vara. The answer to this puzzle is amply given in the works of Gulliver and Canton, especially the latter.

As was mentioned before, the interest of Cooper and Bell culminated in establishing the doctrine of nonunion of the fractures of the femoral neck. They bent to this purpose all their observations. Excluding the possibility of union in cases of intracapsular fractures of the neck of the femur, they used the concept of interstitial absorption to explain the numerous autopsy findings of shortened necks and sessile heads. To explain away the cases with reduced angle but maintained length of the neck, they resorted to the arbitrary assumption of a quasiphysiological occurrence of interstitial absorption, an "idiopathic affection" that was supposedly a manifestation of senescence. By the adoption of this view they have blocked the path to the recognition of coxa vara, on which they so promisingly started.

That this crude outline is in a good measure true to the actual happenings, one may easily gather from Canton.

Canton more than Gulliver before him, is disinclined to accept the lessening of the angle of the femoral neck as part of senile involution but, deferring before the authority of Cooper, smothers his own doubts under an imposing array of quotations from contemporary literature.

He lines up Knox,[61] Harrison,[52] Cruveilhier,[32] Wilson,[122] Elkington,[37] Cooper,[30] Erichsen,[38] etc., teachers, lecturers, authors all; they testify that the lessening of the angle of the femoral neck is a sign of old age. Thus, this learnedly supported error of first magnitude became firmly established in England and also in France. It was rather late when Humphry,[53] in 1889, adopting the stand made by Lane[67] (1886), in a large and thorough anatomical study corrected this misconception, for in the meantime Mueller,[79] Hoffmeister and Kocher made the medical world acquainted with the coxa vara and no notice was taken of the fact that Humphry clearly described the coxa valga.

The concept of interstitial absorption, in particular the knowledge of its juvenile occurrence was kept alive in England with publications by Fayrer[40] in 1862, Quain[87] in 1884, and Jones[55,56] in 1882 and 1887. Of this latter group of writers Quain in his textbook restates the concept in great detail and by adding his own clear and correct opinion concerning the pathological process, marks the high point of development of Bell's idea. It is of interest that Quain gives the photographic illustration of Gulliver's specimen preserved in the Army Medical Museum, which bears out Gulliver's description more strikingly than the engraved sketch accompanying his article forty-eight years earlier. (Figs. 7, 8 and 9.) Jones' textbook closes English publications, as far as the author could ascertain, on this topic in 1887, the year before Mueller announced the coxa vara.

The period of Cooper produced another clinical and pathological picture, the malum senile coxae. The origins of this entity became somewhat obscured by the vicissitudes it underwent soon after it came into being. The first and thorough description was given by R. W. Smith[103] (1834). This entity, which in the last hundred years has grown into the problem of arthritis deformans is, in the opinion of the author, intimately connected and fundamentally identical with all the other conditions that are the subject of this paper.

Smith considered trauma the causing factor, but obligingly deferred before Stanley[104] who suggested "chronic rheumatic" influences; and it was under the name of "chronic rheumatic

arthritis" that Adams[1] incorporated it in the Cyclopaedia of Anatomy and Physiology in 1836–1839. The designation malum senile coxae, however, survived probably due to the fact that

FIG. 7. Gulliver's specimen photographed forty-eight years later by Quain, 1884.

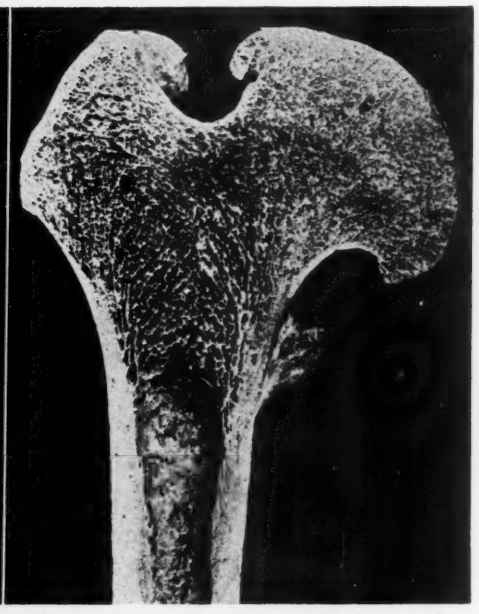


FIG. 8. Same specimen as in Figure 6, cross section, Quain, 1884.

Wernher[117] enthusiastically transplanted the concept to Germany under this name. There at the hands of Virchow and Ziegler[125] the topic received thorough investigation. Ziegler's work in 1877 on subchondral changes, laid the modern foundations of arthritis deformans leading eventually to the differentiation of its juvenile form by repetition of the path evolved by B. Bell and his followers in England. It is of interest to note that Ziegler's findings were described and illustrated by Canton[26] in detail in 1848.

France has actively participated in the investigation and discussion of topics brought forward by Cooper and his contemporaries. A great deal of material on these deformities was demonstrated and published mostly under the name of "arthrite sèche" somewhat confusingly, as this term eventually became identified with Adams' "chronic rheumatic arthritis" (Quain, R., Dictionary of Medicine, 1895). No detailed account of this material will be given in this paper, particularly because a publication of Ollier,[80] in 1881, dwarfs them all by its importance.

In his article "Juxta-Epiphyseal Sprain" (De l'entorse juxta-épiphysaire . . .) Ollier outlines a concept of obscure injuries caused by forced movements, in joints of children. He envisions

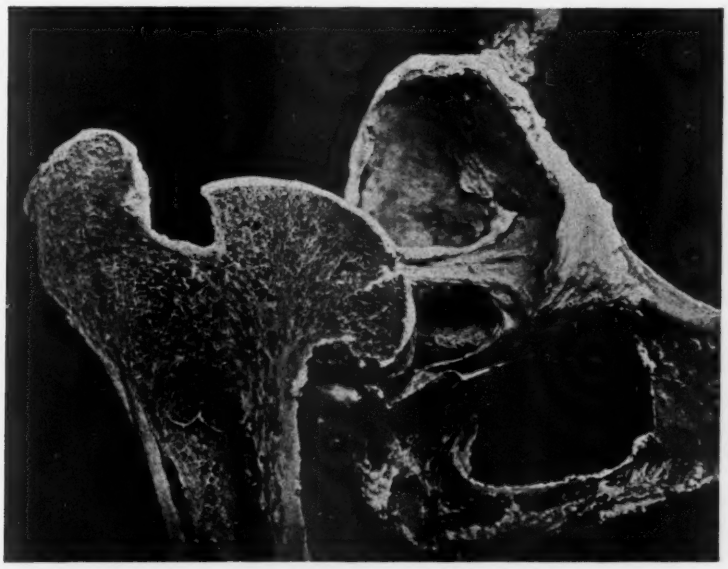


FIG. 9. Specimen of another case of Gulliver's. Quain, 1884.

and experimentally produces (Fig. 10) "intimate lesions of the juxta-epiphyseal spongiosa" and reasoning "on its consequences on the nutrition of the bone," he correctly concludes that "these injuries are the first degree of epiphyseal separation." In this short review no adequate justice can be given to this work of Ollier, which shows the problem in many of its details with great clarity.

These bibliographical findings proved to the author that the knowledge of these various deformities occurring in the hip was more or less thoroughly familiar considerably prior to Mueller. The question remained whether the elusive clinical picture that accompanies the course of these deformities in the making, escaped the observant clinicians of this period.

There is ample evidence to show that they were indeed conscious that under the blanketing manifestations of tuberculous hip disease (which under other names they well knew) there hides at times a more diaphanous symptom complex.

Brodie,[21] in 1837, speaks of hysterical manifestations in the hips "even of young males." Paget,[81] in 1875, speaks of nervous mimicry. With the development of the concept of hysteria and the differentiation of Charcot's disease the discussion centers on the hip joint, and

coxalgia (Fricke[44] 1833), nervous coxalgia, pseudocoxalgia become intensely debated topics. The voluminous literature that resulted cannot be given space in this article, though it is of bibliographic

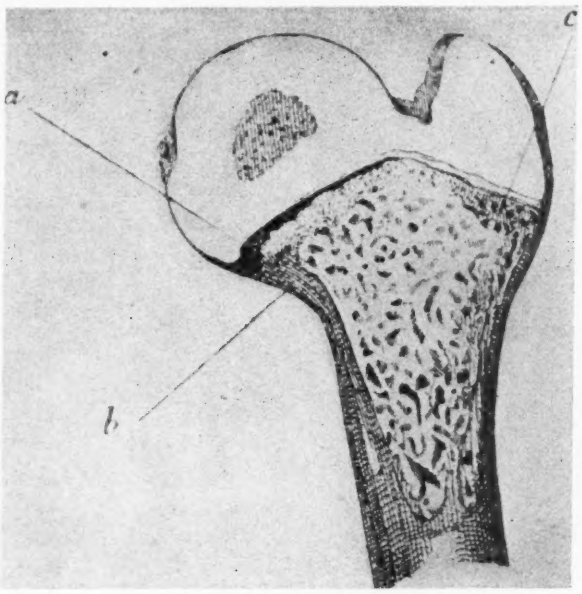


FIG. 10. Beginnings of epiphyseal separation experimentally produced by Ollier, 1881. *a*, beginning separation; *b*, periosteum; *c*, crushed bone tissue.

interest to follow Wernher,[118] Minich,[77] Bauer,[9] Shaffer,[99] and others as they segregate the symptoms that, as we know today, accompany the slipping of the femoral epiphysis and the course of the Waldenstroem-Legg-Calvé-Perthes' disease.

Gibney's[47] construction of the clinical picture of the "neurosis of the hip" without knowledge of the underlying process cannot fail to impress any clinician. He speaks of "age of occurrence around or before puberty," of "difficulty of differentiation from true hip disease," "quick fatigue and muscular spasm," "recurrence of symptoms after remissions," "peculiarity of gait indicative of pain or fear, otherwise difficult to describe," and occasional "prominence of the affected hip."

The tide of discussion abruptly subsided with the demonstration of other than nervous bases of these "hip-joint neuroses." This topic reached greatest development and survived the longest in France where Calvé[25] himself described the disease named with others after him, as a "particular form of pseudocoxalgia."

A survey of the American literature of this period also led to interesting findings.*

Richardson,[90] in 1860, twenty-eight years before Mueller,

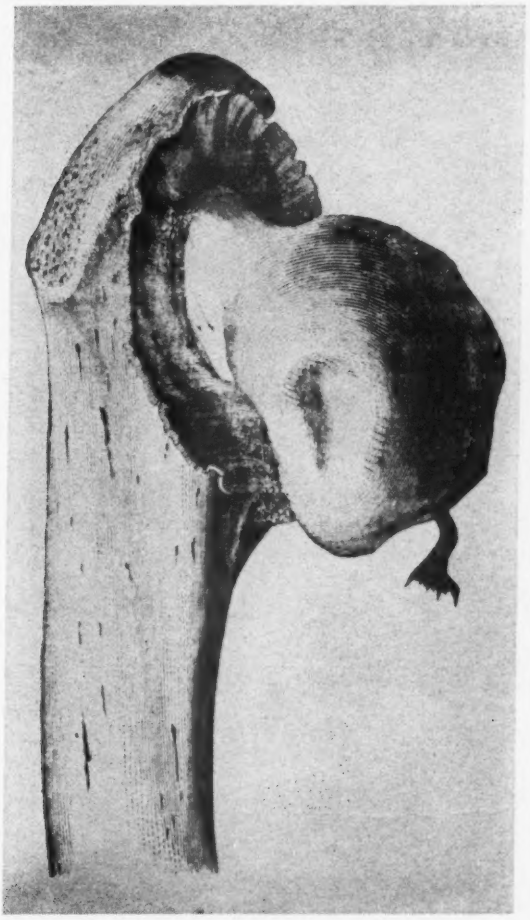


FIG. 11. Richardson's specimen of coxa vara, 1860. Imprint on the head, possibly primary focus.

describes and illustrates coxa vara in a twenty-five to thirty year old male. By the bilaterality of the deformity he excludes healed fracture of the neck, describes the head "enlarged, spread-out, and rendered irregular at its junction with the neck by deposits of little nodules of new bone." (Fig. 11.)

Monks,[78] in 1886, describes "a case of unusual deformity of both hipjoints" that developed in the course of two years in a sixteen year old boy. The lucid clinical analysis together with his

* Known to R. Whitman.[120]

line drawings (Fig. 12) support the assumption of bilateral slipping epiphysis that progressed to coxa vara deformity and enlargement of the head. Monks himself is "forced" to conclude that the case

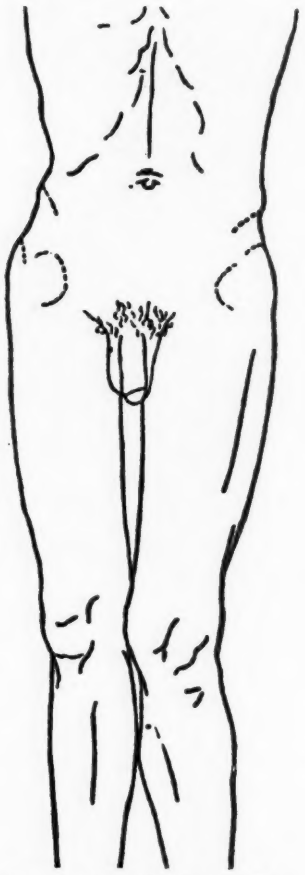


FIG. 12. Monk's illustration of coxa vara, 1886. Note dotted line contour of upper end of femurs.

is juvenile occurrence of arthritis deformans, and thus is the first one to consider this possibility and to use this term with equally as much justification as those who proposed it later.

The concept of Bell's interstitial absorption also found its way to America. Beside Hamilton's broad view of the topic in 1884, Vance,[111] taking his start from Quain, gives a thorough résumé of the concept and illustrates it by a case of his own in 1890.

The description of coxa vara by E. Mueller in 1888 may well be considered the beginning of the modern period of orientation on this and related subjects. The huge mass of publications that resulted

will at the present not be discussed as they are more or less well known.

The author wishes to make one exception concerning an article

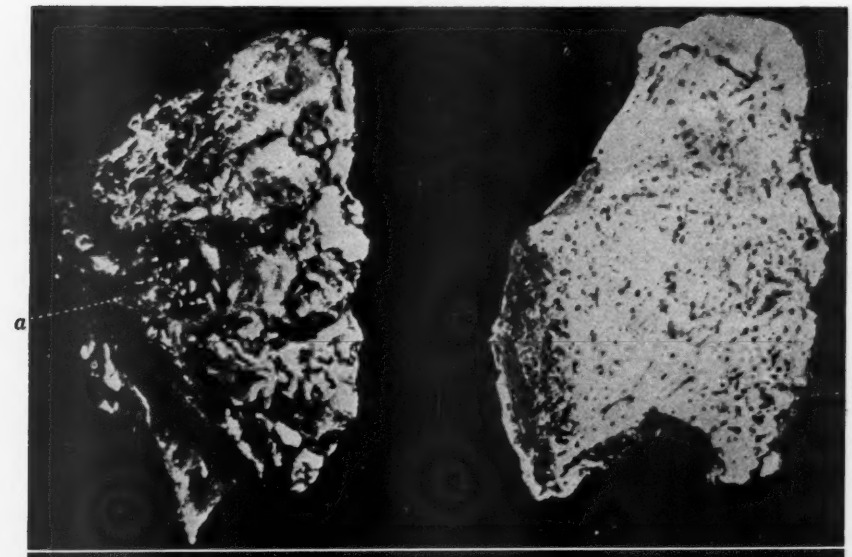


FIG. 13.

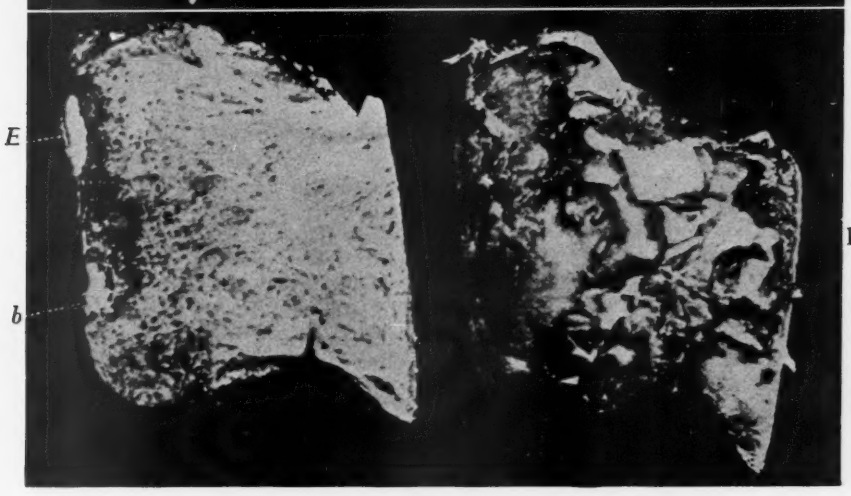


FIG. 14.

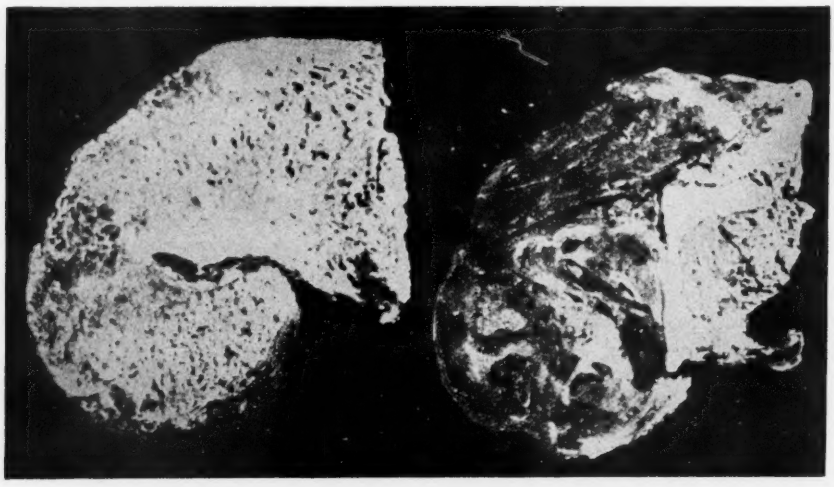
FIG. 13. Maydl's specimen (1897) of what later became known as Legg-Perthes' disease. *a*, posterior view; *b*, cross section; *E*, remnants of the femoral head.

FIG. 14. Another specimen of Maydl's, of the same condition as in Figure 13. *a*, anterior view; *b*, cross section; *E*, remnant of the femoral head.

of Maydl,[72] the importance of which apparently escaped most reviewers.

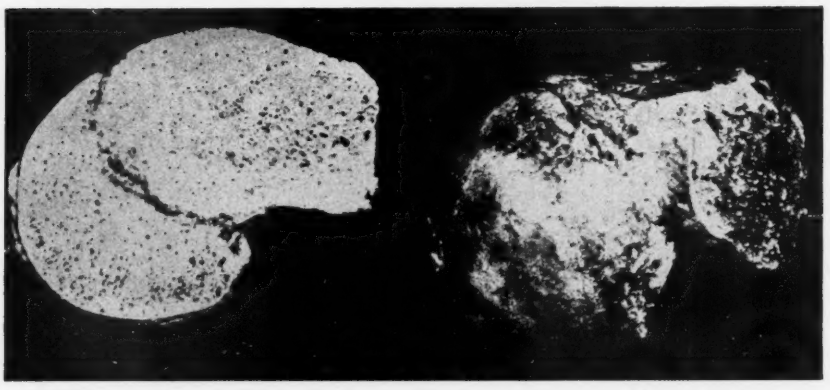
In 1897, Maydl published the photographs of four resected femoral heads that are, as the author could ascertain, the first

well recognizable specimens of Waldenstroem-Legg-Calvé-Perthes' disease (Figs. 13 and 14) and slipping upper femoral epiphyses. (Figs. 15 and 16.)



b *a*

FIG. 15. Maydl's specimen of slipped femoral epiphysis. *a*, anterior view; *b*, cross section.



c *d*

FIG. 16. Another specimen of Maydl's, of the same condition as in Figure 15. *d*, anterior view; *c*, cross section.

In addition, Maydl reveals that the deforming process following traumatic dislocation of the hip was known to him as the traumatic variety of arthritis deformans (Zesas). To this and the original idiopathic (senile) form he proposes to add, on the basis of his four cases, the juvenile form of arthritis deformans which he wishes to separate from the "recently described" coxa vara. Thus, it was Maydl who first conceived this form and used the term in Europe and not Perthes, as is at times believed.

The literature prior to 1888 with the addition of Maydl's publication shows to the satisfaction of the author that the conditions to be discussed in this paper were well known prior to the modern period of research, and that this latter period produced until recently the rediscovery by *x*-ray of the same conditions that were so accurately described in the course of the century before radiography.

COMPRESSION OF CANCELLOUS BONE

After more intimate observation the diseases enumerated and some others occurring in different parts of the skeleton began to be considered interrelated. Notable attempts at systematic grouping were made by Burckhardt[23] who gathered them around the central entity of arthritis deformans, following the course of emergence of these diseases in the German literature, and by King[59] who aligned them as "rarefying conditions of bone" reminiscent perhaps of Bell's approach.

The connecting link of these conditions is, as generally accepted, the aseptic necrosis of the bone involved. The knowledge of aseptic necrosis of bone, the quiet necrosis of Teale[107] and Paget,[81] has attained exact clarification by Axhausen,[4,5,6] Cordes,[31] etc., in Germany, and Phemister,[85] in America. Through the efforts of these authors and others, this process is well known in many of its aspects with the notable exception of the question of how the necrosis originates.

Of all the proposed explanations the "infarct theory" of Axhausen is the most prominent. This theory is based on the observation that the necrotic areas often show on cross section the wedge shape characteristic of infarcts. These infarcts, according to Axhausen, are caused by "bland emboli" that do not produce suppuration and thus leave the necrosis aseptic.

This theory, in spite of the fact that bacterial and air-emboli actually were demonstrated as causes of bone infarcts, encountered scepticism, even among its early supporters. Thus far, however, no other explanation was found plausible enough to be accepted in its place.

The author—as he believes—has found an explanation that solves the question of the underlying cause of aseptic bone necrosis and clarifies the relationship of its numerous clinical manifestations.

The characteristic wedge-shaped areas of aseptically necrotic bone may be produced by a mechanism other than infarction,

namely, by compression of a spherically-shaped portion of cancellous bone. The results of compression applied to a spherically-shaped body are illustrated in the example of a bruised apple in Figures 17 to 21.

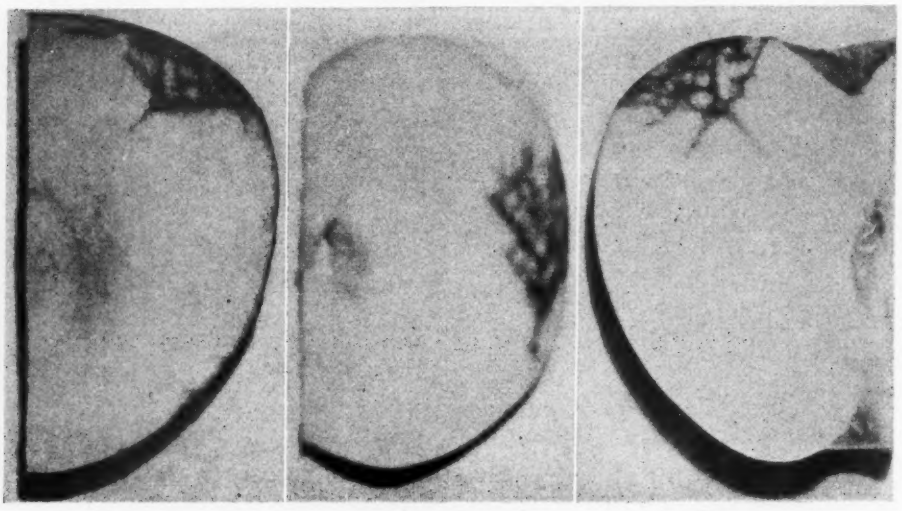


FIG. 17. FIG. 18. FIG. 19.

FIG. 17. Typical compression wedge in a bruised apple.
FIG. 18. Double wedge following double impact.
FIG. 19. Compression wedge showing bisecting compression planes.

They demonstrate the following: (1) If subjected to compression, a spherically-shaped body will suffer damage in an area that is wedge-shaped on cross section. (2) In three-dimensional actuality this area corresponds to a cone with its base at the site of application of force. (3) The compression does not damage the whole substance of the cone, but is most effective on the jacket of it. (4) Within its compression pattern, secondary component wedges are demonstrable. (5) Each impact produces its own wedge. (6) The wedge itself is produced by bisecting compression planes, inside of which the substance may be undamaged. (7) Changes in the curvature of the surface and the speed of force alters the shape of the compression pattern, and if the change occurs during the insult, combination patterns result and patterns may superimpose one another.

By correlating these observations with the fact, the significance of which escaped notice, that all the diseases under consideration occur in cancellous bone and at such places where the bone presents a more or less spherical surface, the author arrived at the concept of compression of cancellous bone which, he is convinced, is the

sole underlying cause of all these diseases, and may well be considered an entity because, while manifest in a variety of clinical pictures, it presents at all times the same pathological features.

If cancellous bone is subjected to force which is greater than its

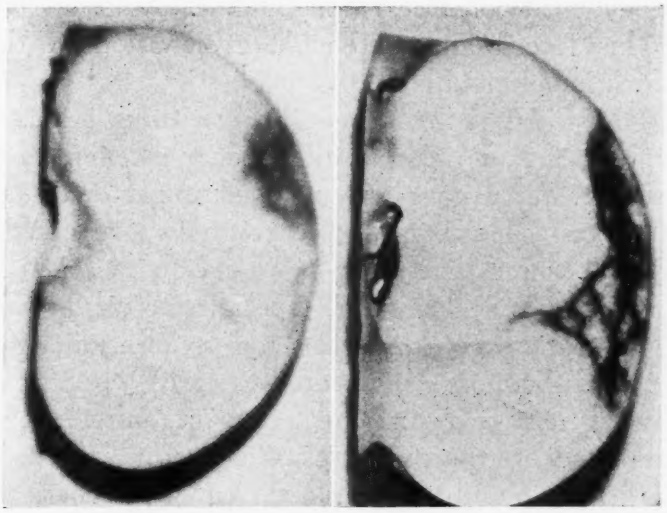


FIG. 20. FIG. 21.

FIG. 20. Compression focus of rounded contour produced by slow pressure.

FIG. 21. Compression figure by sharp impact followed by rolling. The wedge shows maximum compression on the outer borders and undamaged areas between secondary compression planes.

maximum of structural strength, its architecture will collapse. This collapse obeys the laws of mechanics, and the minute girders of the cancellous structure break at places predetermined by these same laws. The broken mass of trabeculae interrupt the flow of blood and causes necrosis of certain, also predetermined segments of bone.

As illustrated, in the case of a spherically-shaped segment the place of collapse is the jacket of a cone, and this whole cone is rendered necrotic, not by embolism of a vessel entering the apex of the cone as presumed by Axhausen, but by compression of all and any vessel entering the cone on its entire jacket.

The necrosis thus mechanically produced is aseptic.

Mechanical factors underlying the occurrence of aseptic bone necrosis were and are considered by many writers. Axhausen[4] himself, prior to his adoption of the infarct theory, believed in traumatic etiology. Walter,[114,115] formerly a supporter of the embolic hypothesis lately also accepted the traumatic view. Mau[71] in his ingenious experiments laid new foundations for the mechanical

theory. Cordes[31] in his remarkable studies effectively advanced the knowledge of mechanics in question. In his lucid invocation and illustration of the laws of mechanics in osteochondritis dissecans Roesner[93,94] came near to the view of the author. He failed, however, to realize the identity of the far-flung manifestations and was misled hereby to his forced and untenable explanation of the infarct pattern which he adopted later.

The parts of the skeleton that harbor these diseases contain besides cancellous bone, also cartilage, in particular in childhood and adolescence. Cartilage is in its physical properties fundamentally different from cancellous bone and reacts to compression differently. It was fair to assume that being more elastic the cartilage is less "vulnerable" to physical injuries, especially to compression. Opinion, however, to the contrary was and is occasionally expressed and the author, therefore, endeavored to verify the behavior under compression of these two component elements in question. Femoral heads of rabbits were thoroughly crushed and examined. Under the microscope it was found that while the cancellous bone was transformed into an unrecognizable mass of débris, the minute particles of cartilage retained their normal appearance. The assumption, therefore, that it is the cancellous bone that suffers most of the damage by compression and that cartilaginous parts escape more or less unharmed, seemed justified.

In applying these premises to the compression of the femoral head at different stages of development, that is, at different age periods, it became obvious that the different clinical forms observed in children and adolescents are determined solely by the ratio or relative amount of cartilage and bone in the femoral head at the time of injury.

INDIVIDUAL MANIFESTATIONS

A. In the Femoral Head. A more or less fully developed femoral head covered by the normal thickness of articular cartilage will respond to compression as illustrated in the diagram in Figure 22. This the author considers the mechanism of origin of the osteochondritis dissecans, the prototype of all lesions, as it represents compression of cancellous bone in its least complicated form. This mechanism explains the occurrence of this disease only in curved segments of cancellous bone, and the presence of undamaged bone within the free bodies. The secondary compression planes answer

the question rightly raised by King[59] concerning multiple free bodies associated with a single bed.

The femoral head that harbors in a young child a smaller or

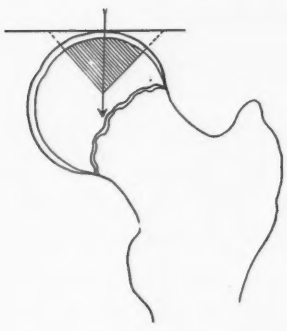


FIG. 22.

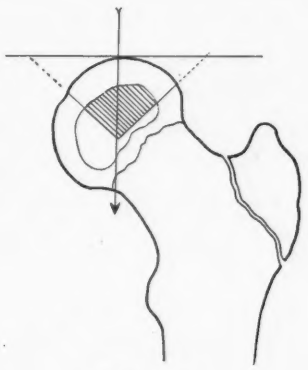


FIG. 23.

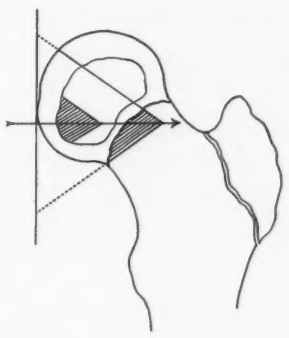


FIG. 24.

FIG. 22. Mechanism of origin of osteochondritis dissecans.
FIG. 23. Mechanism of origin of Waldenstroem-Legg-Calvé-Perthes' disease.
FIG. 24. Mechanism of origin of slipping femoral epiphyses. Note double foci.

larger osseous center beneath a thick cartilage covering responds to compression as illustrated in the diagram in Figure 23. The cartilage itself escapes the damage of compression which becomes effective only in the bony center. Observation of his cases over prolonged periods revealed to the author that while the cartilage escaped harm, the vessels traversing it on their way to the ossification center also may suffer from compression. The effect of this develops later and brings forth in the subsequent osseous growth of the head the typical compression crater at the site where it was kept latent previously by the cartilage, as will be illustrated in the case reports. This diagram illustrates the mechanism of origin of the Waldenstroem-Legg-Calvé-Perthes' disease, which will be recognized as essentially a subchondral osteochondritis dissecans, occurring under the thick cartilage of the femoral head. In support of this mentioned relationship of the two diseases the author wishes to point out the parallel of occurrences in the capitellum of the humerus. In the fully developed capitellum osteochondritis dissecans occurs; while in earlier stages in the presence of a small ossification center and thick cartilage covering, the disease named after Panner[83] develops, which is identical with the Waldenstroem-Legg-Calvé-Perthes' disease, differing from it only insofar as it is determined by the absence of weight-bearing.

A femoral head somewhere between the two stages illustrated, will respond to compression according to the diagram in Figure 24. Articular and epiphyseal cartilage escape compression, which is

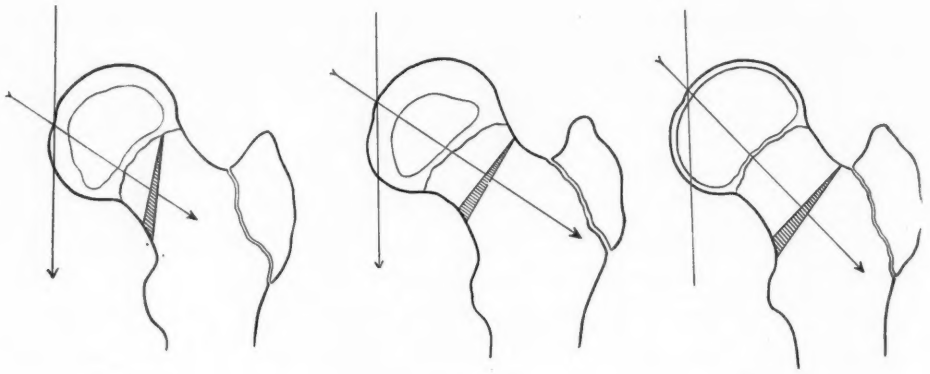


FIG. 25. FIG. 26. FIG. 27.

FIG. 25. Compression wedge close below the head, crossing only part of the neck.
FIG. 26. Compression wedge across entire neck.
FIG. 27. Compression wedge at the base of the neck.

effective on the head and both sides of the epiphyseal plate. In the necrotic area at the epiphyseal plate a lesser or greater part of this most important element of anchorage of the head on the neck is destroyed and the slipping of the head is made possible. The fact that besides the damaged area at the epiphyseal plate there is almost regularly a primary compression area on the head, has escaped notice and will be demonstrated.

B. In the Femoral Neck. The three described forms result if the total force of compression is spent on the head. The force, however, may continue to be effective on the femoral neck, and produce damage that manifests itself in various clinical forms.

The author found that whenever effects of compression are present in the neck, there is necessarily a primary compression area on the head also, in the segment which furnishes the fixed point during the compression. The presence of these primary foci has escaped notice and at times careful search is necessary to discover them. The author offers the demonstrable presence of these primary compression foci in support of the correctness of this concept. These primary foci are likely to be absent in younger children when the head is still covered with a thick cartilage that escapes unharmed and does not register the insult while the compression develops its damaging effect on the neck.

The femoral neck is cylindrical and the compression pattern occurring in the course of hypothetical bending is an actual wedge lying across the length axis of it. This wedge may occur at any place between the epiphyseal plate and the base of the neck. Diagrams in Figures 25 to 27 illustrate the places where the compression wedge most frequently occurs.

The clinical pictures resulting from these compression wedges in the neck are designated by different names and great confusion exists in respect to these diseases. The author has ascertained that the same findings are considered and described by one group of authors as congenital coxa vara, and as fractures of the femoral neck, by another.

R. Whitman[119] in a publication, in 1891, described these cases of juvenile fractures of the femoral neck. He clearly discerned with but little aid of radiography, that besides the frankly violent and instantaneously disabling fractures of the femoral neck, which occasionally do occur in children, and besides the epiphyseal separation known long before, there occurs not seldom in children a peculiar fracture of the femoral neck. The features of this he accurately described; arbitrarily summarized they are those of a not totally disabling pathological fracture. Irrespective of this, due to the fact that some of these findings occur quite early in childhood, a group of writers elected to describe these cases as congenital coxa vara.

The consideration of rickets and late rickets, etc., also added to the confusion.

Seen from the viewpoint of compression of cancellous bone these conditions observed in the femoral neck reveal their uniform meaning.

The necrotic bone of the compression wedge, as it undergoes mainly absorption, weakens the site and leads under weight bearing to alteration of shape and angle of the neck, or complete interruption of the continuity.

The compression wedge in Figure 25 leads to what is most often described as congenital coxa vara; those in Figures 26 and 27 are the most common Whitman juvenile neck-fracture types, the last one having been described by Taylor[106] as the "hinge fracture" of the neck of the femur of children.

COMPRESSION OF THE ACETABULUM

In the instances enumerated the compression damages the femoral head and neck. It is obvious, however, that the same amount

of pressure as on the head is also active on the acetabulum, against which the head is levered during the trauma. This often causes compression in the subchondral cancellous structure of the ace-

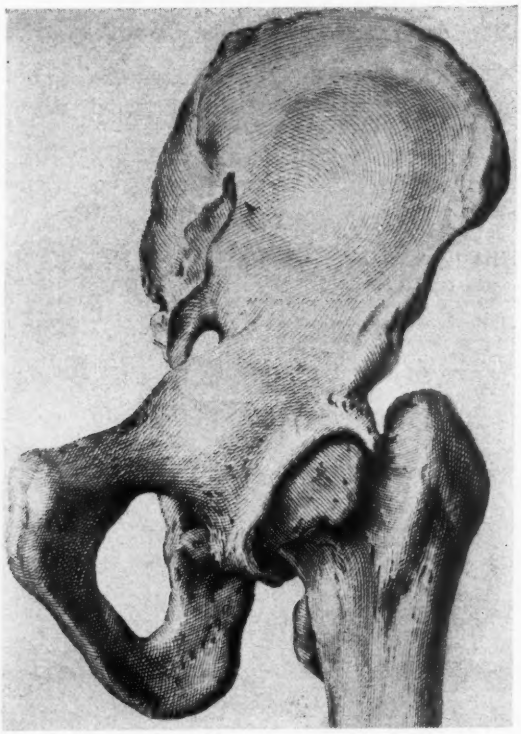


FIG. 28. Otto-Chroback pelvis in the Sandifort Atlas, 1793–1835.

tabulum and leads to the changes that were often observed, and have been described as osteochondritis of the acetabulum, acetabular Perthes' disease, etc. In these cases the compression may leave its mark on the head also, and the site of the latter indicates the position in which the damage originated. (Case XXII, Figs. 101 and 102.)

COMPRESSION OF THE PELVIC GIRDLE

The two hip joints, in fact the whole pelvis, may be considered a functional unit. In the course of several combinations of motions, the whole pelvic girdle may be placed under excessive stress. The existing epiphyseal plates absorb part of the pressure; but if the force is sufficient, the cancellous bone on both sides of these cartilaginous plates will be compressed in the sense of Ollier's "juxta-epiphyseal sprain." This is how the ischiopubic osteochondritis

(Van Neck),[110] and the osteochrondritis at the symphisis pubis (Burman)[24] may originate.

Compression alongside the cartilage plate of the acetabulum proper was not so far demonstrated beyond doubt, but the very controversial topic of ischium varum, and other irregularities in the relative position of the component bones of the acetabulum suggest that such compression and the following misalignment may be among the origins of the deformity named after Otto and Chroback.

This condition, too, was known considerably earlier than generally believed and is illustrated in the Sandifort[98] atlas. (Fig. 28.)

ARTHRITIS DEFORMANS OF THE HIP

The malum senile coxae, as R. W. Smith[103] conceived it, was a traumatic disease but soon it was incorporated into the group of "chronic rheumatoid arthritides," although Canton[26,27] had clearly voiced the opinion that the changes in this disease and those observed in interstitial absorption are very similar, and the former like the latter may follow a "bruise of the hip." A concise exposition of the traumatic nature of "the so-called disease rheumatoid arthritis" was forcefully given by Lane[67] in his classic essay which, although published as early as 1886, is definitely ahead of the prevailing opinion of today concerning this topic, the importance of which is amply indicated by the frequent compensation-court disputes.

Observations of early stages of arthritis deformans of the hip enabled the author to demonstrate that compression of cancellous bone is the underlying pathological process also in this condition. The typical wedge-shaped compression pattern may be found in the femoral head if observed before it collapses. (Case XXI, Figs. 99 and 100.)

This identity of nature of the process in both the senile and juvenile manifestations of interstitial absorption was also sensed by Canton.[27] Of late Putti[86] and some of his school[109] voiced the same opinion. In an earlier publication the author[16] also expressed similar belief.

COMPRESSION AT THE SACROILIAC JOINTS

During the last decade continental and American observers described changes at the sacroiliac joints, in particular at the iliac

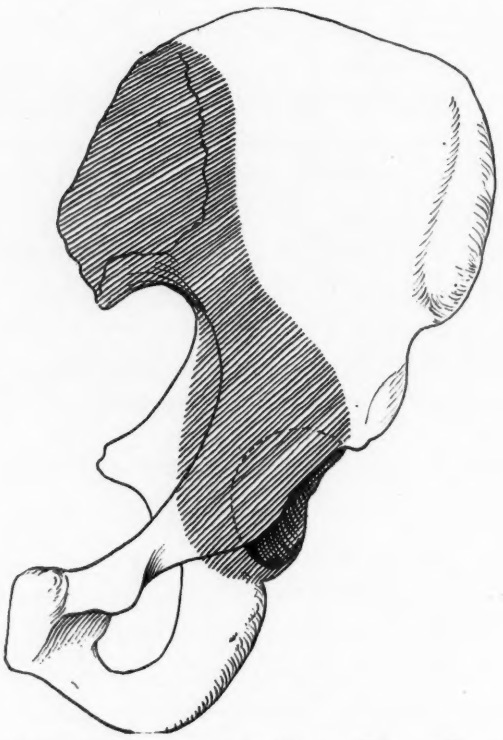


FIG. 29. The "coxo-sacral strut" in outline.

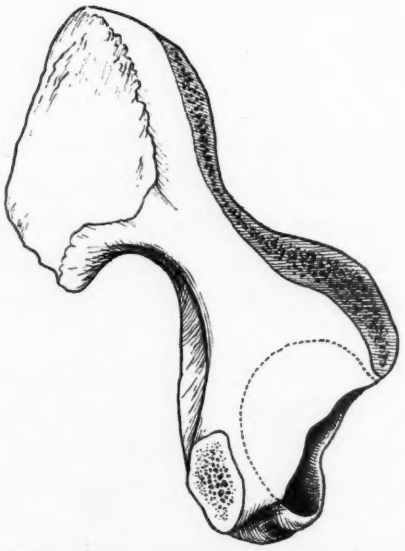


FIG. 30. The "coxo-sacral strut" shown after cutting away the nonweight transmitting portions of the pelvis.

side. These were registered somewhat arbitrarily as condensing osteitis of the ilium. (Bársony,[8] 1928, Rendich,[89] 1936.)

Irrespective of this, Rogers[95] (1935) correctly aligned well defined

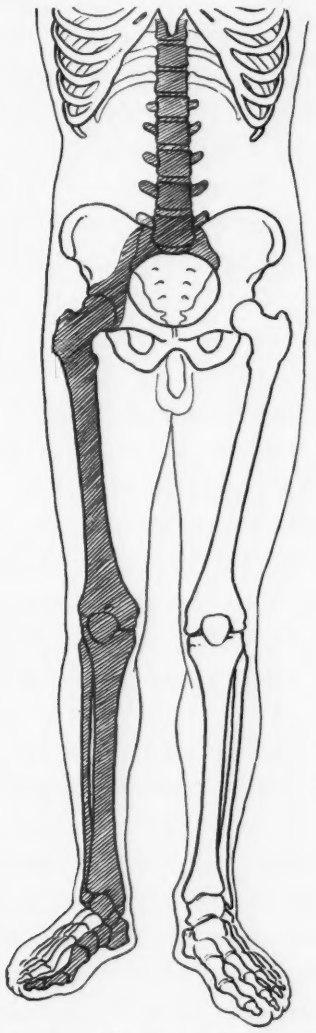


FIG. 31. The path of transference of weight from the lower extremities to the spine.

juvenile cases showing such changes with the general group of "osteochondritides as represented by Perthes' disease" and established the entity "adolescent sacroiliac syndrome."

The author shares the opinion of Rogers and, searching for the mechanism of compression, came to the following conclusion:

The weight bearing member between the femoral head and sacrum is only the solid portion of the iliac bone along the innominate line. This portion the author considers a functional unit and named it "coxosacral strut." (Figs. 29 to 31.) The stresses, strains and shocks incidental to upright weight bearing are transmitted from the lower extremities to the spine by the means of this strut. In it, proximal to the plane of transference of force, under excessive demands compression of the cancellous architecture may occur with the resulting aseptic bone necrosis. The actual presence of this necrosis the author was able to verify in drill specimens taken from these areas, as will be shown in the case reports. (Cases XXIII, Fig. 104.)

COMPRESSION OF CANCELLOUS BONE ACCOMPANYING FRACTURES

Fractures in or near segments of cancellous bone are invariably accompanied by compression of this structure, as recognized long ago. The feature which did not receive full appreciation is that in these circumstances massive necroses occur which dominate the clinical picture. Fractures of os calcis, upper end of tibia, etc., derive their protracted course from the presence of these necrotic masses which undergo absorption and substitution very slowly. Drilling is helpful in these instances, as will be reported in a separate publication.

Minute compressed foci may accompany infractions of vertebral processes and may explain a certain group of cases of "low back pain."

If it appears that the concept of the author is too widely scattered, it should be noted that it never passes beyond the boundaries of cancellous bone, not even in the instance of its most bizarre caricature, Charcot's disease. Further, it is not intended to blanket with this concept the recently described little known changes based as believed on developmental disturbances of the cartilage.

SEQUELAE OF COMPRESSION

The results of the various mechanisms of compression are identical, namely, aseptic necrosis of a portion of cancellous bone. The histological process these necrotic areas undergo, as was stated, is well known and will not be discussed at this time, with the exception of such of its aspects as, in the opinion of the author, have not been fully appraised.

Due to the accepted fact that these foci are aseptic, all-too-complete innocuity is attributed to them. Necrotic tissue within the body even if aseptic, elicits reaction from its surrounding. The reaction is not violent and consists mainly of edema. This reactive edema explains the clinical symptoms that accompany the course of all these diseases. The edema pervades the surrounding soft tissues, increases the amount of joint fluid, leads to spasm, stiffness and pain. It explains satisfactorily the paradox stiffening of joints after rest and limbering up after use. The edema spreads evenly during rest in the synovial membrane capsule, etc. With assumption of motion, functional creases have to be created in the soft parts much like in the sleeve of a new overcoat; but after the edema is squeezed out of these creases, a sense of limberness appears and increases until rest again allows the even spreading of edema and the disappearance of the creases. In the case of the hip this edema is deep and hardly palpable, but at times, as the author believes, it reveals its presence by blurring of the soft tissue markings in the *x*-ray picture. This edema persists as long as there is any trace of necrotic bone present and causes fibrosis of the muscles directly or indirectly, leading eventually to pseudoankylosis in the presence of massive foci.

This reaction, which misled some observers to suspect infection, is not instantaneous. The necrotic foci, due to the very mechanism that created them, in most instances become sealed off against the rest of the body. The compression barrier that with continued stress of use becomes more and more impenetrable, acts together with the cartilage as a closed container which prevents the necrotic material to exert its irritating effect. The reactive edema and clinical symptoms appear only when in the course of spontaneous repair vessels find their way, as demonstrated by Axhausen, around the compression barrier into the foci, and open these to the flow of blood and lymph.

This circumstance explains the period of latency that separates the injury from the clinical appearance of symptoms.

That this sealing-off actually takes place is also indicated by certain secondary changes that occur in the necrotic foci; changes that are not observed under other circumstances in necrotic bone. It seems as if in these sealed-off foci a certain interreaction of the component elements occurred, more or less physicochemically with the exclusion of biological influences. Whether calcium salts are actually in

solution there, as Leriche assumed it to be the case around fractured bone ends, and whether these salts enter into formation of insoluble calcium-soaps much like in the formation of adipocere are questions

FIG. 32. Drill specimen from Case XVII. Necrotic bone with empty lacunae. Degrees of homogenization of compressed bone. Absence of living marrow elements.

of importance, particularly because, as the author had ample occasion to observe, there exists in the presence of these changes a marked degree of readiness to new bone formation. These changes lead to a marked degree of homogenization of the necrotic area, as observable on the actual specimen, and together perhaps with calcium in solution cause the blurring or loss of bone structure in the *x*-ray picture. In a former publication the author stated that these foci yield continuous ribbons of a homogeneous material that fills the grooves of the drill and is grossly and microscopically different from the occasional bone spicules obtained from living cancellous areas.

Detailed analysis of these drill specimens cannot be given in this paper. Living and dead portions of bone are clearly indicated in them, the latter not alone by the absence of any bone cells but, as was repeatedly indicated, by the complete absence of all marrow elements. (Case XVII, Fig. 32.)

FORCE

Concerning the force that produces these lesions there can be little doubt. Direct trauma acting in the direction of the neck, attacking at the greater trochanter does lead to compression in the neck and head as was clearly recognized by Bell, Canton and others. The majority of these cases, however, develop after other types of traumatism than those ordinarily designated as accidents, or after accidents that mask the participation of the hip.

As may be construed from the mechanical analysis of these lesions the force obviously acts indirectly and is multiplied by leverage in its intensity. The multiplying effect of leverage is not fully appreciated as is shown by the acts of force in reducing congenital dislocations of the hip by the closed method. The length of the limb divided by the length of the neck gives the ratio in increase of force in extreme adduction and abduction, the fulcrum assumed roughly at the intertrochanteric line.

Single insult registers itself in a clear-cut pattern of compression. Repeated trauma causes superimposed compression cones that blur and confuse the picture. The typical instance of the latter is the reduced, unreduced, and, especially, repeatedly reduced congenital dislocation.

For the very early cases the possibility of birth traumas deserve consideration. This is well recognized, because they are immediately apparent in the injuries of the upper extremities which hardly ever are subjected to such forcible handling as the lower ones. Concrete playgrounds and ball courts, and roller-skating tumbles on pavement, etc., may well account for a good number of injuries.

For the instances of arthritis deformans and the adolescent sacroiliac syndrome, of course, instead of a single insult, repeated traumas have to be assumed. Temporary or permanent loss of elasticity of gait due to fatigue or old age, with the countless small shocks it involves, may well be the causative agent. An extreme illustration of this may be seen in Charcot's disease in which the reflex muscular suspending mechanism of weight bearing is lost. The mushrooming of the cancellous substance over the condyles of the femur so often found in the aged is an illustration in lesser degree.

The intensity of force multiplied by leverage must overcome the structural strength of the cancellous segment placed under

pressure. If this strength is inferior to the average, lesser force may bring about the same compression.

The author knows of no investigations regarding physical properties of cancellous bone in the adipose-type children. Such investigations may or may not show lessened structural strength. The fact, however, that in these obese children compression damages are often observed does in itself not prove that certain endocrine disturbances do render the skeleton more susceptible to compression, because in a number of instances the same compression damages occur in known normal skeletons.

Dislocated hips in the athletic young and other perfectly normal persons, as has been known since Virchow, Zesas[124] and Maydl,[72] and which is being observed currently in a large number of cases, often show one or two typical compression foci produced by the dislocation and the reduction maneuvers, respectively.

A similar lesion was observed by the author in the head of the mandible after dislocation.

Another large group of these compression foci are observed accompanying fractures of the hip both in the intertrochanteric and, particularly, in the intracapsular types.

These compression or, as they are called, "absorption areas" are not "late damages" (Bergmann[12]) nor secondary consequences, but they are integral parts of the same injury that produced the fracture. The diagram in Figure 33 shows the author's conception of the mechanism in the case of an adduction fracture. It shows the compression wedge in the head at the site where the head is levered against the acetabulum and the compression wedge in the neck which is divided into two parts by the fracture proper.

These compression areas are at the bottom of most peculiarities this fracture represents. Concerning them, in particular those in the head, certain gross predictions may be made before they appear.

The younger the injured person and the stronger the neck of the femur, the more probable that foci will appear. Before the neck actually breaks, the head is subjected to considerable pressure, this being little or nothing in old persons whose femoral necks break easily. This circumstance accounts for the devastating absorption in the femoral head of vigorous middle aged persons, and explains that these are often observed in the present era of automobile and other violent accidents, and were seldom seen in old persons whose femoral necks break without gross violence.

These violently produced compression foci with their known date of injury support the author's conclusions about the period of latency. They will furnish us eventually with the length of period

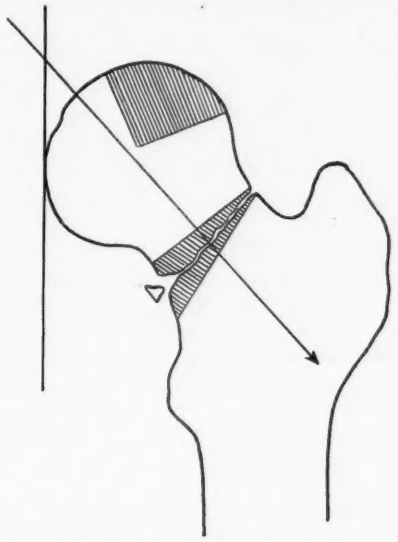


FIG. 33. Mechanism of origin of intracapsular fracture of the femoral neck in the adult. Note compression at both proximal and distal fracture surfaces and primary compression focus in the head.

that elapses between injury and clinical symptoms, that is, the onset of reaction to the necrotic tissue. At the present the author estimates this period to be four to six months.

TREATMENT

Correlating the processes of the spontaneous repair, as demonstrated by Axhausen,[6] with the concept of compression of a cancellous bone segment, led to the therapeutic principle of the author.

Axhausen[7] describes and shows the compression barrier, the "mass of bone meal" as he names it, impenetrable to nature's efforts to send capillaries across it into the foci of necrotic bone. Delitala[35] in his minute histological description of the same process tells of how capillaries "excavate a fine channel" (si scava un canale fino) across the epiphyseal plate into the head.

It appeared reasonable to expect that the penetration of the compression barrier by drill channels might facilitate the spontaneous healing process.[18] The trials were successful in a marked degree, and on their basis the author[19] came to the conclusion

published in an earlier paper that "an area of aseptic bone necrosis anywhere in the skeletal system may be advantageously treated by connecting the necrotic segment with an adjacent living segment of bone by means of drill channels."

The occurrence of compression in the femoral head and neck as previously outlined demanded that the drill channels be laid in the axis of the neck in order to penetrate any and all compressed areas. The route used by the author, the drilling from the greater trochanter, is, therefore, not merely a convenient operative approach.

Drilling, trephining or tunneling of bone in general or the femoral neck in particular, are old procedures. They arose from the convergence of Brodie's[20] classic undertaking (1832) of evacuating isolated bone abscesses by drilling into them, and the older practice of using setons to provoke productive irritation. Stanley[104] (1849), Kirkpatrick[66] (1867), J. Greig Smith[102] (1871), W. Th. Stoker[105] (1886), McNamara[74] (1887), Quénu[88] (1896), Delagénière[34] (1896), Davies-Colley[33] (1897), etc., report the extensive use of "tunneling" in the treatment of tuberculosis of the hip, of epiphyseal abscesses in the femoral neck and even of chronic (nontubercular) osteitis. Setons, on the other hand, were used to combat nonunion of fractures of long bones. The various endeavors in this field culminated in the work of Brainard[22] (1854) who not only described a procedure of drilling for nonunion of fractures of long bones but also gave a remarkably correct concept of its working principle. This work and the principle gradually became forgotten, but Loreta,[70] in 1888, performed an operation uniting the seton and drilling principle in a case of delayed union of a fracture of the base of the femoral neck by placing five metal setons and removing them after five days. Robertson Lavalle,[91,92] in 1919, described the use of bone grafts in the treatment of tuberculous osteoarthritis, and explained and demonstrated the results obtained by the penetration of new vessels from the graft into the diseased area. The drilling for nonunion was revived in 1929 by Beck[10] who, however, did not see anything "fundamentally new" in it, but a simple way of creating hematomas at the fracture site. The technical simplicity of this procedure as popularized by Boehler[14] appeared eminently adaptable for the purpose of breaking through compression barriers, and the author recommended its use in November, 1930, for instances in which such barriers presumably occurred, and performed it for the first time in January, 1931.

Among attempts of earlier date Phemister's[85] (1921) operative removal of a necrotic focus from a femoral head affected by "Perthes' disease" did not receive the merited attention. The excellent result did not lead to adoption of the clear-cut procedure, possibly because of the rôle of infection stressed by Phemister and apparently supported by operative reports of Kidner[58] (1916) and McWorther[75] (1924). Cordes,[31] in 1930, published a well conceived plan of an operation for Perthes' disease. Ferguson and Howorth,[41] in June, 1931, described a major procedure "to hasten the ossification of the epiphyseal disc," closely following the plan of Cordes missing, however, the dominant rôle of necrotic bone so clearly stressed by him.

The intimate knowledge of the repair processes following aseptic bone necrosis led to new and more correct avenues of therapeutic approach. Katzenstein[57] endeavored to influence the course of repair by transplantation of healthy bone marrow. Konjetzny[64,65] in a conscious effort to follow the course of spontaneous healing used in Koehler's disease, advised for the so-called "malacia" of the carpal semilunar osteotomies to lay open the foci to repair, a procedure which was practised by Jones[54] for the treatment of Osgood-Schlatter's disease. Zanoli[123] (1935), three years after the author, utilized drilling from the femoral head as part of a major operative intervention.

All diseases under consideration possess great tendency to spontaneous recovery. The drilling serves only to facilitate and hasten the processes of this natural healing and its ultimate aim is the removal of all necrotic tissue from the foci by these same processes. The result is commensurate with the degree in which new bone is substituted for the necrotic, but the removal of the necrotic tissue is the first postulate. As long as such portions are still present, the disease is at best latent and may flare up any time and lead eventually to arthritis deformans. The newly deposited bone, if injudiciously subjected to weight bearing and other demands, may in its turn collapse and give the disease a new start. It should be protected by all available means.

CASE REPORTS

GROUP OF OSTEOCHONDRITIS DISSECANS

Besides the osteochondritis dissecans proper, the necrotic foci developing in the femoral head after traumatic dislocations and

fractures of the neck of the femur also belong to this group by reason of their identical mechanism of occurrence (leaving out the consideration at this time of Koehler's disease, etc.).

FIG. 34. Case 1. Roentgenogram August 29, 1930; beginning separation of an osteochondritic focus.

FIG. 35. Case 1. Roentgenogram January 13, 1931; nearly complete separation of sequestrum.

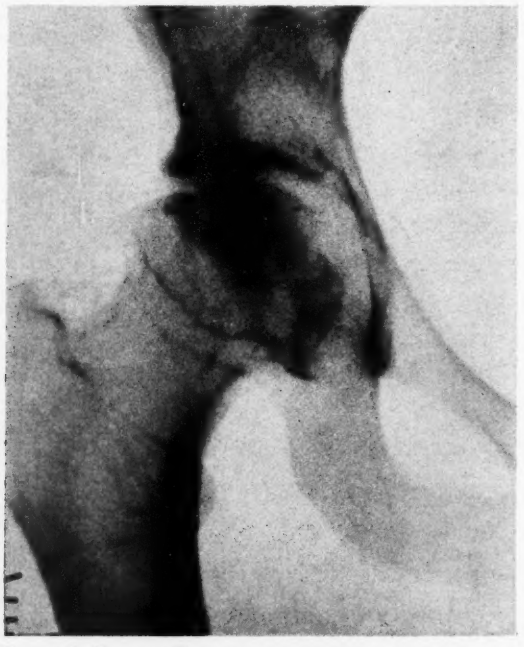


FIG. 36. Case 1. Roentgenogram five years later, March 8, 1937; fairly well preserved contour of the head; spur formation with smooth outline on upper border of the neck and head.

The material of the author falling in this group is small, but what there is indicates that the drilling should be performed as early in the course of the disease as possible.

CASE 1. S. R., a twelve year old girl, had a minor bobsleigh accident, March, 1930, and a slight limp developed. *X*-ray examination August 29, 1930, showed incipient separation of a supposedly dissecting osteochondritic focus. (Fig. 34.) Subsequent *x*-ray pictures verified the diagnosis, and examination, January 13, 1931, revealed an apparently separated sequestrum in the head of the right femur. (Fig. 35.) Permission for operation was not obtained until January 31, when five channels were drilled into the head of the femur. A plaster spica was applied for a period of eight weeks. The patient was discharged May 2, 1931, with free motions and painless weight bearing in the right hip. Half-yearly checkups were made. *X*-ray examination six years later, March 8, 1937, showed a fairly well preserved head with small spur formation. (Fig. 36.) At the last clinical examination January 12, 1940, function was very satisfactory but abduction somewhat limited. Activities at work and play are unhampered. Period of observation covered nine and one-yalf years.

It seems reasonable to assume that with drilling four to five months earlier, the normal contour of the head could have been preserved and the spur formation responsible for limitation of abduction possibly avoided.

GROUP OF WALDENSTROEM-LEGG-CALVÉ-PERTHES' DISEASE

Instances of this disease present at time precarious situations in respect to spontaneous repair. When compression damages only a part of the osseous center, the repair may start from the unharmed portion. When, however, the whole center is compressed, resulting in the destruction of its vascularity and the severing of vessel connections with the surrounding cartilage, the necrotic ossification center will be cut off from all sources of capillaries; and it may be questionable whether these may reach it in time to allow both the absorption of the necrotic material and the resumption of growth of the head.

This circumstance explains the amazing chronicity of cases of this disease at a period of life when repair is the swiftest and when foci of identical nature and size in more accessible places of the skeleton are eliminated in a few weeks; and this accounts mainly for the fact that necrotic portions may remain in the head for eight or ten years unabsorbed and unsubstituted as was found by Konjetzny.[64,66]

The drilling into the necrotic center of the head is of striking benefit. Its effects develop in two phases that are fairly well sepa-

rated. First, a swift absorption of all necrotic material occurs; subsequent to this the normal growth of the head is resumed. The first phase is indicated by the appearance of marked contrast within the ossification center, due to absorption of necrotic portions. The absorption completed, the second phase or normal growth of the head starts on its way. The ultimate outcome depends on, and may be predicted by the amount of cartilage present at the time of drilling. The greater this *cartilage reserve* the more perfect the end result. This demands that the drilling be done as early as possible. If the cartilage reserve is small, the drilling is of even greater urgency, because a thin cartilage covering is not sufficient to cushion against further deformation and itself may wear through and so lead to the destruction of the head.

The appearance of the head during the first phase may be quite alarming at times. Fragmentation may become more pronounced than it was before the drilling. Observations during the last seven years convinced the author that this increased fragmentation is the result of absorption of necrotic parts and indicates no danger. As long as there is a thick cartilage layer over the bony center, however badly fragmented, the outcome will be good. Arthrography as described by Sievers[101] and Severin[100] will remove the guess work as to the amount of cartilage reserve, but this may be calculated correctly enough on the usual *x*-ray picture. In the second phase a wedge-shaped defect may appear on the fairly well developed head. This, as stated, marks in the opinion of the author the area in the cartilage where compression damaged the vessels and ossification is consequently retarded. These areas persist for a long time, but eventually become filled up and do not necessitate a second drilling. The flat appearance of the head, besides its actually lesser height, is in a measure due to the slipping of the head in the same manner as observed in the cases of slipped epiphyses. This circumstance, although noted by Waldenstroem[113] in his first publication (1909), is not generally recognized; it is clearly demonstrated in Figures 50, 53 and 59.

As a basic plan the author recommends accurate drilling as early as possible, plaster of paris spica immobilization for six to eight weeks, protective brace until *x*-ray examination proves that all necrotic portions were absorbed. Beyond this period, in the opinion of the author, protection against weight bearing is no more necessary than it is for the femoral heads of healthy children during

normal growth. For the time being, however, until more material can prove the safety of this view the author uses and recommends the use of a brace as long as the children can be induced to wear it.

FIG. 37. Case II. Roentgenogram April 26, 1933; irregular head with flattened contour and abnormal structure; broadened neck.

FIG. 38. Case II. Roentgenogram five weeks after drilling, June 21, 1933; marked absorption of portions in the head and contrasting structure.

CASE II. P. W., a seven year old boy, gave a history of pain, limping and stiffness in the right hip for half a year. On the basis of clinical and repeated *x*-ray examinations the diagnosis of Waldenstroem-Legg-Calvé-Perthes' disease was made. (Fig. 37.) A plaster of paris spica for three months brought no relief. The drilling operation was performed on May 11, 1933, and a short knee-length spica applied. The patient was discharged five days postoperatively. Six weeks after the operation the spica was removed. *X*-ray examination the following day showed that marked contrast developed in the ossification center, and portions of it became absorbed. (Fig. 38.) A brace was recommended, but the patient was not heard of until three and one-half years later, in February, 1937, when the parents stated that, as the child walked about without pain, no brace was used. The child at that time had no symptoms whatever, attended school, and participated in all exercises during the three and one-half years that elapsed. *X*-ray examination February 12, 1937, showed the femoral head fairly well developed, with a crater-shaped defect of ossification in its middle portion. (Fig. 39.) Half-yearly checkups were made. *X*-ray examination February 8, 1940, (Figs. 40 and 41) shows well shaped and developed head both on the anteroposterior and lateral views. A faint trace of the one-time crater is indicated. Range of motion was complete. The period of observation lasted seven years.

CASE III. J. B., a five and one-half year old boy, had pain in the right hip, a limp and increasing inability to walk for a period of eight months. Hospital observation and prolonged bed-rest at home were carried out but

FIG. 39. Case II. Roentgenogram three and three-quarter years after drilling; development of head well under way; crater of retarded ossification at site of vessel damage in the cartilage.

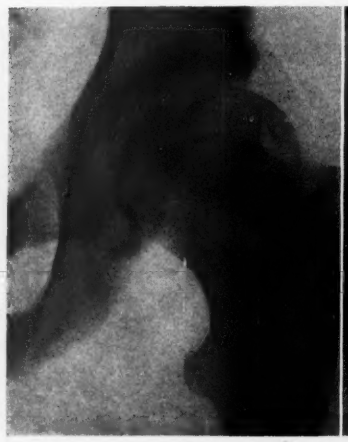


FIG. 40. Case II. Roentgenogram six and three-quarter years after drilling, February 8, 1940; well developed head of good structure.

FIG. 41. Case II. Lateral view same day as Figure 40; well developed head; trace of crater faintly perceptible.

there was no improvement. *X*-ray examination on May 19, 1934, showed an area of bone destruction in the upper-outer segment of the head and neck. (Fig. 42.) The child was kept in bed at home without marked improve-

ment, and permission for operation was not obtained until September 8, 1934, when three channels were drilled into the head in the direction of the focus. No spica was applied. Six weeks rest in bed followed. *X*-ray exami-

FIG. 42. Case III. Roentgenogram May 19, 1934; area of bone destruction indicated in upper-outer segment of head and neck.

FIG. 43. Case III. Roentgenogram six weeks after drilling, October 25, 1934; marked absorption in the focus indicated in Figure 42, with contrast in bone structure.

nation on October 28, 1934, showed a well developed contrast at the site of the focus with marked absorption of the involved area. (Fig. 43.) A brace was worn for six months. The child reported to follow-up only two and one-half years later, when the parents stated that after the brace was discarded the child continued with his activities without symptoms. The child has been seen yearly since then. *X*-ray examination February 10, 1939, showed well shaped and developed head on both the anteroposterior and lateral views. Epiphyseal line showed irregularity at the site of the original focus but no other abnormality. (Figs. 44 and 45.) Range of motion is complete. The period of observation lasted five years.

CASE IV. R. D., five year old boy, had pain in the left hip, a limp and inability to stand and walk, for a few weeks. *X*-ray examination of the left hip on November 24, 1934, showed a typical picture of Waldenstroem-Legg-Calvé-Perthes' disease. (Fig. 46.) The drilling operation was performed on November 28, 1934, followed by bed-rest in the hospital for eight weeks. *X*-ray examination on February 4, 1935, showed what was then thought very alarming fragmentation of the ossification center of the head (Fig. 47), and for this reason a plaster of paris spica was applied for three months. After removal of the spica a brace was applied. The child was seen every two months and while the *X*-ray pictures still looked very discouraging, the clinical symptoms gradually disappeared and the child walked

FIG. 44. Case III. Roentgenogram four and one-half years after drilling, February 10, 1939; no trace of abnormal structure, well developing head; neck somewhat broadened.

FIG. 45. Case III. Lateral view, same day as Figure 44; irregularity of epiphyseal line at site of focus; no other abnormality.

FIG. 46. Case IV. Roentgenogram November 24, 1934; typical findings of early Legg-Perthes' disease.

FIG. 47. Case IV. Roentgenogram seven weeks after drilling, February 4, 1935; alarming fragmentation of the head; two drill channels visible.

about without concern and the brace performed obviously no function whatever except perhaps restraining his activities. *X*-ray examination on October 4, 1935, still showed marked fragmentation, but something of a

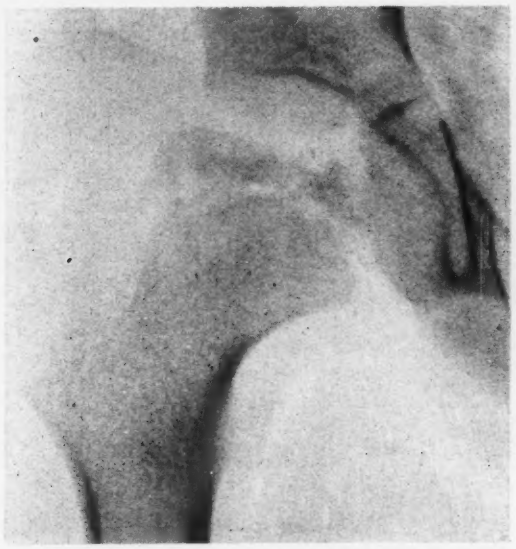


FIG. 48. Case IV. Roentgenogram thirteen months after drilling, February 6, 1936; growth of head well under way.

reshaping of the ossification center could be perceived. At this time the child was entirely without clinical symptoms and used the brace only while in school. The brace was discarded when *x*-ray examination, February 6, 1936, showed that the regrowth of the head was definitely on its way. (Fig. 48.) Follow-up examinations were made at half-year intervals. *X*-ray examination showed a steady growth of the head. The last *x*-ray examination on February 13, 1940, showed the femoral head well shaped and developed and the neck of good length without broadening. (Fig. 49.) Lateral view shows slight off-center position of the head. (Fig. 50.) Range of motion is complete. The period of observation covered five and one-quarter years.

CASE V. A. L., seven year old boy, gave a history of pain and limp in the left hip. *X*-ray examination on November 9, 1934, showed irregular ossification center and epiphyseal line of the left hip. (Fig. 51.) The diagnosis of Waldenstroem-Legg-Calvé-Perthes' disease was made and the drilling operation performed on November 16, 1934. A plaster of paris spica was applied for eight weeks but no brace. Home conditions necessitated hospitalization for two additional months, after which the child was transferred to an orphan home where he was under constant supervision. Half-yearly checkups were made. *X*-ray and clinical examinations showed steady growth of the head and absence of symptoms. The last *x*-ray examination on February 10, 1940, showed a fairly well shaped and developed

head. (Fig. 52.) Range of motions is complete and the child is pursuing all activities at school. The reduced height of the head as seen on the antero-posterior view is to a great extent only apparent and is due to the slipped

FIG. 49. Case IV. Roentgenogram five and one-quarter years after drilling, February 13, 1940; well developed head and neck, normal bone structure.

FIG. 50. Case IV. Lateral view, same day as Figure 49; head is slightly off center.

FIG. 51. Case V. Roentgenogram November 9, 1934; early Legg-Perthes' disease.

FIG. 52. Case V. Roentgenogram five and one-quarter years after drilling; well developing head somewhat off center.

position of the head as it is plainly noticeable on the lateral view. (Fig. 53.) The period of observation covered five and one-quarter years.

CASE VI. L. L., a five and one-half year old boy, had marked pain in the left hip, a limp, and inability to walk, except short distances for a

period of four months. *X*-ray examination February 6, 1935, corroborates the clinical diagnosis of Waldenstroem-Legg-Calvé-Perthes' disease. (Fig. 54.) The drilling operation was done on February 19, 1935. A spica was

FIG. 53. Case v. Lateral view, same day as Figure 52; head well shaped and developed but in a marked off center position.

applied for eight weeks and a brace for fourteen months. *X*-ray examination April 15, 1935, showed marked contrast developing in the ossification center of the head assuming the appearance of osteochondritis dissecans. (Fig. 55.) *X*-ray examination on July 10, 1935, showed the full development of this subcartilaginous osteochondritis dissecans. Sequestrum and its bed from which it separated were plainly visible. (Fig. 56.) Clinical symptoms steadily decreased and the child became more and more active. February 26, 1936, a year after drilling, *x*-ray examination showed that while a small portion of the sequestrum still persisted, the growth of the head was definitely under way. The child could be restrained only with great difficulty, but owing to the fact that the osseous center of the head was apparently off center, an endeavor was made to continue with the brace, which was discarded only sixteen months after the operation. Half-yearly checkups were made. *X*-ray examination September 11, 1936, showed progressing growth of the head; a small portion of the sequestrum was still visible, the outlines of compression crater indicated on the head. (Fig. 57.) The child was last seen February 10, 1940, when the *x*-ray examination revealed a well shaped and developed neck and head (Fig. 58), the latter somewhat displaced posteriorly as indicated on the lateral view. (Fig. 59.) The period of observation covered five years.

FIG. 54. Case VI. Roentgenogram February 6, 1935; typical picture of early Legg-Perthes' disease.

FIG. 55. Case VI. Roentgenogram nine weeks after drilling, April 15, 1935; absorption in the head bringing about picture of osteochondritis dissecans.

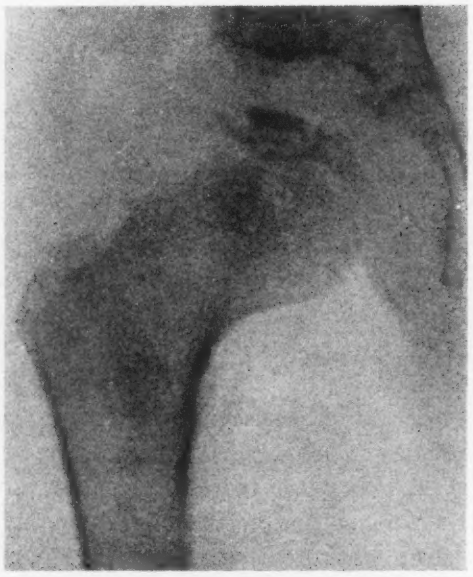


FIG. 56. Case V. Roentgenogram July 10, 1935; picture of osteochondritis dissecans fully developed.

FIG. 57. Case VI. Roentgenogram a year and one-half after drilling, September 11, 1936; growth of head resumed, vestige of sequestrum visible; compression crater in head outlined.

FIG. 58. Case VI. Roentgenogram five years after drilling, February 10, 1940; well shaped and developed head and neck; normal bone structure.

FIG. 59. Case VI. Lateral view, same day as Figure 58; head slightly off center.

CASE VII. J. E., a seven year old boy, had marked pain and spasm in the right hip, inability to stand on right leg and to walk any but short distances. The duration of symptoms was ten months. On clinical and *x*-ray

FIG. 60. Case VII. Roentgenogram seven months after drilling, December 24, 1935; head still fragmented, compression crater clearly outlined.

FIG. 61. Case VII. Roentgenogram four and three-quarter years after drilling, February 8, 1940; well developed head and neck; normal bone structure.

FIG. 62. Case VII. Lateral view, same day as Figure 61.

evidence the diagnosis of Waldenstroem-Legg-Calvé-Perthes' disease was made. (*X*-ray pictures of that period cannot be located.) The drilling operation was performed on May 23, 1935. A plaster of paris spica was applied followed by bed-rest for seven months. *X*-ray examination on

December 24, 1935, showed the ossification center of the head still fragmented, the outlines of a crater indicated on its middle. (Fig. 60.) Subsequent *x*-ray examinations showed filling of this defect and fusion of the fragmented parts within one year and half postoperatively. For reasons of precaution rest in bed alternating with spica was continued for another ten months after which the child resumed normal activities. For one and three-quarter years the child could not be located, but when found was well and active, *x*-ray examination showing well developing head. He was last seen February 8, 1940, when the *x*-ray examination at that time showed a well shaped and developed head and neck on both anteroposterior and later views. (Figs. 61 and 62.) Range of motion was complete. The period of observation lasted five years.

GROUP OF SLIPPING EPIPHYSES

As was stated, the underlying cause of the slipping of the head is the necrosis at the epiphyseal plate, in particular, distal to it. Continued weight bearing often frustrates spontaneous repair by crushing the newly formed bone. When pain and spasm intermittently immobilize the patient, absorption of the necrotic parts and the deposition of new bone may be so well balanced that the head may wander great distances on the neck without actually separating from it.

Many features of this disease may be explained by simple mechanical interpretation. The head wanders downward and onto the posterior surface of the neck because the place of easiest escape is the intertrochanteric fossa. One glance at the upper end of the femur from above fully reveals this situation. Femoral heads after complete and incomplete neck fractures invariably follow the same direction.

Owing to this direction of slipping, the synovial membrane at the lower surface of the neck lifts into a fold. This fold is part of the normal synovial membrane and not the result of inflammatory redundance. Its inflamed appearance is due to mechanical irritation in the crowded joint, and not, as at times it was believed, to "primarily infectious" reasons.

In the same way as the synovial membrane, the periosteum of the neck may also lift into a fold at the lower contour of the neck and produce there new bone, as has been observed since the days of Bell, Cooper and Canton.

As these soft part coverings of the neck fold below and behind, they become tautly stretched in front and above. At times they

thicken and produce cartilage patches, at others they wear away and the bone and epiphyseal cartilage may become exposed. Particles of the latter may be rubbed off into the synovial membrane or into the free joint, thus bringing within the possible consequences the condition called chondromatosis.

The sudden and complete separations need no further explanation with the exception that it is not generally realized that upright weight bearing is one of the mechanical factors that tend to keep the head on the neck. Sudden complete slips while asleep are explained by the absence of this stabilizing element and by the direction of force across the neck when shifting the body in a horizontal position.

Drilling in the instances of this disease brings uniformly good results. The necrotic areas are rapidly absorbed, the epiphyseal plate disappears in most instances, and head and neck fuse firmly. Drilling freezes, as it were, the existing situation. The author recommends six to eight weeks' plaster of paris spica immobilization after operation, with subsequent brace protection against weight bearing. The larger the area of necrosis at the time of the drilling, the longer should be the period of brace protection. In cases of complete separation protection against weight bearing should be practiced for prolonged periods, possibly two years or more, and the condition carefully checked by *x*-ray examination at quarterly intervals. Any ill conceived hurry to produce spectacular results may end in the disaster of deforming arthritis. If diagnosis will be made early, as emphatically demanded by Mayer,[73] and drilling performed as soon as possible, the results will be swift, perfect and permanent.

The outcome of neglected cases is at times appalling. Arthritis deformans with pseudoankylosis lead to a great degree of permanent disability. At times a curious and little understood condition results as illustrated in Case XVI. A prominent feature of this condition is that the femoral head is markedly enlarged.

Andral[3] reported the condition as an accidental autopsy finding in 1834. It was again briefly outlined by John Sandifort,[127] in 1840, as "augmented volume" of the femoral head. In 1868, Volkmann[112] described it as "true hypertrophy" of the femoral head and attributed it to increased blood supply. Guibal[50] called it "deforming and hypertrophying osteochondritis" in 1922. Recently this condition was described and renamed "coxa magna" by Ferguson and Howorth[126] (1935).

CASE VIII. T. H., a ten year old boy, was first seen July 10, 1931. He had pain and stiffness in the left hip. *X*-ray examination at that time showed slight disturbance of structural detail distal to the epiphyseal plate inter-

FIG. 63. Case VIII. Roentgenogram July 10, 1931; early disturbance of bone structure in neck at epiphyseal plate.

FIG. 64. Case VIII. Roentgenogram November 10, 1931 marked progress of the disease. Vestige of primary compression in head.

preted as necrosis. (Fig. 63.) No permission for drilling was obtained until *x*-ray examination, November 10, showed marked progress of the disease. (Fig. 64.) The operation was performed November 30, 1931. Five channels were drilled into the neck and head. A spica was applied for eight weeks and a brace for ten months. The patient and parent were very co-operative and the child was restrained from strenuous exercises for a second year during which, however, he attended school and was entirely symptomless. Half-yearly checkups were made. *X*-ray examination February 17, 1937, showed a well shaped and fully developed head and normal bone structure. Shortening of the neck was proportionately the same as at the time of drilling. (Fig. 65.) The patient was last seen June, 1939, when the range of motion was complete. The period of observation lasted eight years.

CASE IX. M. McE., a ten year old girl, gave a history of pain and limp of one week. *X*-ray examination on October 19, 1933, showed marked bone destruction in the neck without markedly changed position of the head. (Fig. 66.) After two weeks of traction treatment in bed, the drilling operation was performed October 25, 1933. A spica, first full, then knee length for fifteen weeks was applied. This prolonged treatment in a spica resulted in a moderate stiffening of the knee on account of which rest and careful exercise in bed were carried out till the end of the sixth month after

the operation, when the patient was permitted to walk on crutches. These were gradually discarded. Half-yearly checkups were made during which her condition steadily improved functionally and as to *x*-ray appearance.

FIG. 65. Case VIII. Roentgenogram five years after drilling, February 17, 1937; well shaped and developed head; normal bone structure; fusion of epiphyseal plate.

FIG. 66. Case IX. Roentgenogram October 19, 1933; marked bone destruction in the neck.

FIG. 67. Case IX. Roentgenogram three and one-quarter years after drilling, March 6, 1937; complete fusion of head and neck; normal bone structure; well shaped head.

The last *x*-ray picture, March 6, 1937, showed a perfectly shaped and developed head with normal bone structure. (Fig. 67.) The range of motion was complete. The period of observation covered six and one-quarter years.

CASE X. M. P., a twelve year old girl, was first seen August 1, 1933. She gave a history of pain in the left hip for a period of a month and walked with a marked limp. An *x*-ray picture taken on that day showed

FIG. 68. Case X. Roentgenogram August 1, 1933; marked destruction in the neck; definite slipping of the head.

FIG. 69. Case X. Roentgenogram three and one-quarter years after drilling, March 6, 1937; complete fusion, well shaped head; normal bone structure.

marked destruction in the neck distal to the epiphyseal plate and decided slipping of the head. (Fig. 68.) A plaster of paris spica was applied for two months. No marked improvement took place. The drilling operation was performed on October 11, 1933 and a spica applied for five weeks. Careful exercises and walking on crutches were then permitted. After six months crutches were discarded. The child walked without limp or pain. Half-yearly checkups were made. The last *x*-ray examination, March 6, 1937, showed a perfectly shaped and developed head with normal bone structure. The position of the head was the same as at the time of the drilling and very satisfactory; length of neck was proportionately the same as at the time of drilling. (Fig. 69.) Range of motion was complete. The period of observation lasted five and one-half years.

CASE XI. F. S., an eleven year old girl was first seen August 22, 1934. She gave a history of pain, spasm in the left hip and inability to walk any but short distances. *X*-ray examination showed bone destruction at the epiphyseal plate and beginning displacement of the head. Drilling operation was performed on August 23, 1934, but no spica was applied. Due to circumstances over which the author had no control, the patient left the hospital nine days after operation and was allowed to walk about. On February 6, 1935, the patient again returned with a marked limp and pain. *X*-ray examination at that time showed marked progress of the disease.

(Fig. 70.) A second drilling was recommended. February 21, 1935, five channels were drilled in the neck and head. A spica was applied for eight weeks and a brace for nine months. The condition rapidly improved.

FIG. 70. Case XI. Roentgenogram February 6, 1935; marked slipping of the head and bone destruction in the neck.

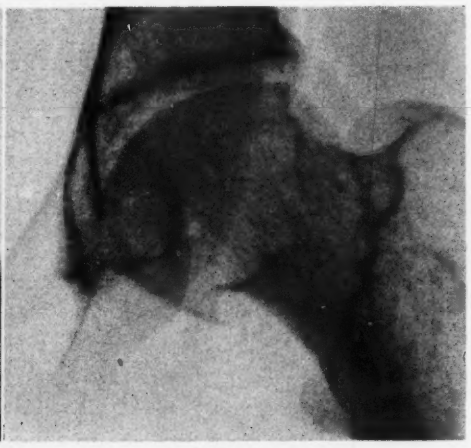


FIG. 71. Case XI. Roentgenogram five years after second drilling, December 30, 1939; complete fusion, well shaped head; normal bone structure.

FIG. 72. Case XI. Lateral view, same day as Figure 71; shape of head well preserved.

Subsequent *x*-ray examinations showed good repair. One year after the second drilling the child was fully active. Half-yearly checkups were made. The last *x*-ray examination on December 30, 1939, five years after drilling, showed the head in the same relative position as at the time of drilling, well shaped and of normal structure. (Figs. 71 and 72.) Range of motion was very satisfactory. There was a trace of limitation of abduction and internal rotation. The period of observation covered five and one-half years.

CASE XII. J. K., a seventeen year old boy, suffered with disability of the left hip for one and one-half years. *X*-ray examination May 23, 1932, showed marked coxa vara and bone destruction distal to the epiphyseal

FIG. 73. Case XII. Roentgenogram May 23, 1932; marked coxa vara, bone destruction in the neck, off center position of the head; primary focus indicated in head.

FIG. 74. Case XII. Roentgenogram one-half year after drilling, November 10(?), 1932; firm fusion; primary focus still outlined in head.

FIG. 75. Case XIII. Roentgenogram February 7, 1932; complete epiphyseal separation of right hip.

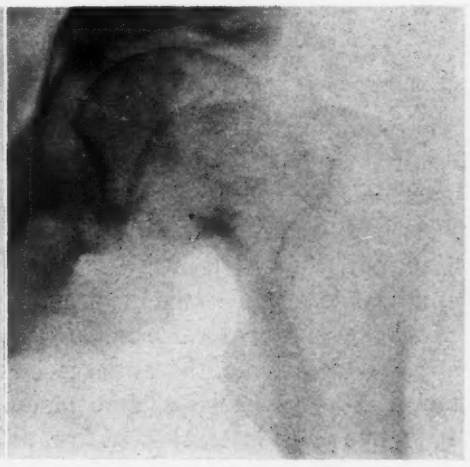


FIG. 76. Case XIII. Roentgenogram three months after drilling, May 7, 1932; maintained continuity between head and neck; definite primary compression focus in head.

plate. (Fig. 73.) Drilling operation was performed June 6, 1932, and a spica applied for eight weeks. Under the care of a private physician measures of protection against weight bearing were carried out. *X*-ray examination on November 10(?), 1932, showed firm fusion of head and neck. (Fig. 74.)

Osteotomy for the correction of the coxa vara was recommended but the patient did not return. The period of observation was six months.

CASE XIII. B. S., a ten year old girl, stumbled and fell on January 12,

FIG. 77. Case XIII. Roentgenogram five years after drilling, February 3, 1937; firm union, fairly well shaped head; primary focus in head still persisting.

1932. Her right lower limb was instantly disabled and she was kept in bed at home. On February 7, 1932, *x*-ray examination showed complete epiphyseal separation in the right hip. (Fig. 75.) On February 10, 1932, the separation was reduced by the author's method of lateral traction, and the drilling operation performed. A spica was applied for the period of eight weeks. Rest in bed and careful exercise were prescribed. On May 7, 1932, *x*-ray examination showed maintained continuity of neck and head and the appearance in the latter of a characteristic primary focus of compression which was not noticeable in the previous pictures. (Fig. 76.) A brace was applied for six months and the child was transferred to a convalescent home. Yearly checkups were made. *X*-ray examination on February 3, 1937, five years later, showed firm union and a fairly well shaped head. The vestiges of primary compression focus were still clearly discernible. (Fig. 77.) Motions were slightly limited in all directions, but the range was satisfactory. She was last seen on February, 1940, when her condition was the same. The period of observation lasted eight years.

CASE XIV. B. S., the same patient as Case XIII. *X*-ray examination on February 7, 1932, was taken of the left hip incidentally with the injured right hip, but revealed no pathological findings. (Fig. 78.) On June 5, 1932, the left hip was again included in the *x*-ray picture taken as a follow-up of the right hip. This revealed a similar compression focus on the left femoral

head (Fig. 79) as was noted on the right. For this reason the author recommended bed-rest immobilization, possibly drilling of the left hip. This was not carried out and the child was permitted to walk about with a brace on

FIG. 78. Case XIV. Roentgenogram February 7, 1932. Normal head and neck of left femur (same patient as Case XIII).

FIG. 79. Case XIV. Roentgenogram July 5, 1932; definite primary compression focus in head.

FIG. 80. Case XIV. Roentgenogram October 14, 1932; complete epiphyseal separation, left hip.

FIG. 81. Case XIV. Roentgenogram five years after drilling, February 15, 1937; firm union, fairly well shaped head; primary compression focus still visible.

the right leg with activities moderately restricted. On October 14, 1932, the patient returned with a completely slipped epiphysis in the left hip. (Fig. 80.) Reduction and drilling were performed on October 25, 1932, and a spica applied for eight weeks. The child returned to the convalescent home. Yearly checkups were made. *X*-ray examination on February 15, 1937, four and one-quarter years after drilling, showed firm union and a fairly well shaped head. Vestiges of primary compression focus were still discernible.

(Fig. 81.) Motions were somewhat limited in the right hip, but range was satisfactory. She was last seen February, 1940, and her condition was the same. The period of observation lasted seven and one-quarter years.

FIG. 82. Case XV. Roentgenogram April 14, 1934; complete epiphyseal separation, left hip.

FIG. 83. Case XV. Roentgenogram two and one-half years after drilling, November 6, 1936; firm union, fairly well shaped head in fair position; normal bone structure.

FIG. 84. Case XVI. Roentgenogram August 1, 1933; old slipped epiphysis with some amount of union; head markedly enlarged and of abnormal structure.

FIG. 85. Case XVI. Roentgenogram eight years previous to Figure 84, January 26, 1926. Original condition: slipping epiphysis.

CASE XV. J. V., a fourteen year old, obese boy fell at home and his left lower extremity was instantly disabled. He remained in bed for two weeks. *X*-ray examination, April 14, 1934, showed a completely slipped epiphysis in the left hip. (Fig. 82.) On the same day reduction and drilling were performed. A spica was applied for eight weeks and brace protection for six

months. His left knee developed a stubborn stiffness that yielded completely only after eighteen months. Constant supervision was carried out. *X*-ray examination, November 6, 1936, showed firm union and normal bone structure. The position of the head was satisfactory. (Fig. 83.) Range of motion was slightly limited in every direction. He was last seen March, 1937. The patient moved but reports by letter indicate good function. The period of observation covered two and one-half years.

CASE XVI. A. H., a twenty-five year old male, gave the history of long disability of the right hip. According to his statement he suffered from "slipping epiphysis" and was treated at several hospitals. Spica and bed-rest with traction were used. *X*-ray examination on August 1, 1933, revealed an old epiphyseal slip with union, the extent of which cannot be well determined. The head appeared enlarged and of markedly abnormal structure. (Fig. 84.) Weight bearing in right hip was fair but painful. The drilling operation was performed on April 30, 1934, after which the patient left city and no follow-up was possible. On inquiry at the hospitals where patient was previously treated it was found that an *x*-ray examination was made January 26, 1926, which proved that the original condition was slipping epiphysis of the right hip. (Fig. 85.) During the seven and one-half years that elapsed between the two *x*-ray examinations the condition progressed from slipping epiphysis to what was lately termed coxa magna, demonstrating the relationship between the two.

GROUP OF COMPRESSION FOCI IN THE FEMORAL NECK

CASE XVII. E. G., a five year old boy, gave a history of trivial tumbles while playing during summer, 1931. No definite accident occurred. There was some pain in the right hip, a very marked limp, reluctance to walk and total inability to stand on the right leg. *X*-ray examination, December 10, 1931, revealed a large triangular subcapital segment of the neck separated without displacement. (Fig. 86.) This segment had the appearance of necrosis. The course of illness was afebrile and the patient was kept in bed. On December 22, 1931, two channels were drilled, one into the axis of the neck and the other into the affected segment. The limb was immobilized. The bone specimen removed in the grooves of drill showed total necrosis. (Fig. 32.) *X*-ray examination on January 28, 1932, five weeks after operation, showed re-union of the detached portion with the neck, the previously necrotic segment evidently being re-vitalized. The two drill channels were visible. (Fig. 87.) Clinical recovery was rapid and complete. *X*-ray examination one year after operation showed no disturbance and good growth. The patient was seen regularly for two more years. He is well and active. The period of observation lasted three years.

CASE XVIII. H. C., an eight year old boy, gave a history of long disability. The mother stated, "both hips were broken when baby was

dropped." *X*-ray examination on January 5, 1932, of the left hip showed marked coxa vara with displacement of the head below the greater trochanter and the neck at a sharp angle with the shaft. Across the neck a

FIG. 86. Case XVII. Roentgenogram December 10, 1931; necrotic subcapital segment separated but not displaced.

FIG. 87. Case XVII. Roentgenogram five weeks after drilling, January 28, 1932; necrotic segment fused to neck; two drill channels visible.

FIG. 88. Case XVIII. Roentgenogram January 5, 1932; marked coxa vara; broad defect across neck.

FIG. 89. Case. XVIII. Roentgenogram June 3, 1932; bony union at the site of the previous bone defect.

broad band of absorption interrupts the continuity outlining a wedge-shaped segment distal to the epiphyseal plate. (Fig. 88.) The same condition was observed in the right hip, on which osteotomy was performed on January 14, 1932. On the occasion of change of spica, January 28, 1932, three channels were drilled through a small incision over the greater tro-

chanter into the left femoral neck. Owing to the presence of spica no *x*-ray picture was taken of the left hip until June 3, 1932. At that time complete bony consolidation was present at the site of the area of absorption that

FIG. 90. Case XVIII. Roentgenogram five years after drilling and osteotomy, March 8, 1937; well developed head and neck.

existed prior to the drilling. (Fig. 89.) Subtrochanteric osteotomy was performed for the correction of coxa vara on September 22, 1932. Half-yearly checkups were made. After June, 1934, the child was irregular in reporting and was not located until March 8, 1937. An *x*-ray examination at that time showed a fairly well developed femoral neck in good position, normal head, and satisfactory bone structure. (Fig. 90.) The child was not very co-operative and could not be restrained as desired. Results were very satisfactory. The period of observation lasted five years.

CASE XIX. P. G., a twelve year old girl, had a sudden "caving in" of the right leg while walking. There was no stumbling and no accident. *X*-ray examination revealed complete intracapsular fracture of the right femoral neck. In view of the very slight injury connected with this complete severance of continuity the possibility of pathological fracture was considered, which was supported by *x*-ray examination during treatment by Russell traction on October 11, 1936, showing smooth fracture edges. (Fig. 91.) The femoral head showed what was interpreted as a focus of primary compression. In view of the youth of the patient bony union was expected. This seemed to be well under way after seven weeks of treatment, as shown by *x*-ray examination on November 21, 1936. (Fig. 92.) However, when traction was discontinued after eleven weeks of treatment, the limb fell instantly into external rotation indicating nonunion, which was confirmed by *x*-ray examination on December 29, 1936. (Fig. 93.) Application

of traction easily restored the reduction previously obtained, but release was immediately followed by falling apart of the fragments. For this reason a plaster of paris spica was applied for eight weeks. After removal of

FIG. 91. Case XIX. Roentgenogram, October 11, 1936; smooth fracture line, marked absorption; primary compression focus in head.

FIG. 92. Case XIX. Roentgenogram November 21, 1936; apparent union.

FIG. 93. Case XIX. Roentgenogram after eleven weeks in traction, December 29, 1936; no trace of union, marked external rotation.

the spica, March 8, 1937, there was no sign of union and the thigh was freely telescoping on the side of the pelvis. *X*-ray examination on this day showed the completely rotated head and the externally rotated distal fragment.

(Fig. 94.) Five months of careful immobilization elapsed without bringing any trace of union. The drilling operation was performed April 5, 1937. Owing to the emaciated condition of the child, immobilization was obtained

FIG. 94. Case XIX. Roentgenogram five months after accident; eleven weeks traction, eight weeks spica; no trace of union.

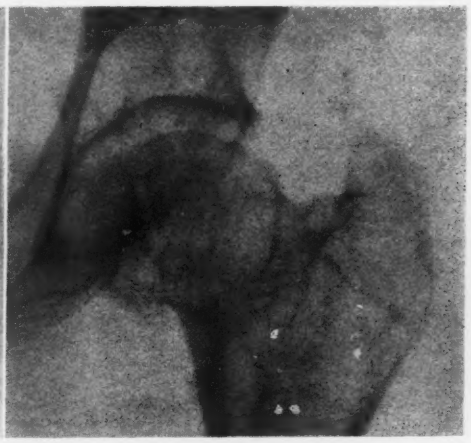


FIG. 95. Case XIX. Roentgenogram two years after drilling, February 24, 1939; firm union, well shaped head.

FIG. 96. Case XX. Roentgenogram July 25, 1936; complete fracture at base of neck, markedly smooth edges.

FIG. 97. Case XX. Roentgenogram July 6, 1938; good union; primary focus in head found.

as best as possible by sand bags. Rapid consolidation ensued and evidences of clinical union appeared after two months. The child was allowed to walk about on crutches four months after drilling. Subsequent clinical and *x*-ray examinations showed steady improvement. *X*-ray examination on February 24, 1939, showed complete consolidation of the fracture with fair position

of the fragments and good bone structure. (Fig. 95.) Weight bearing was perfect and painless, and range of motion nearly complete. The child pursues all her activities unhampered and is unaware of any physical shortcomings. The period of observation lasted three and one-quarter years.

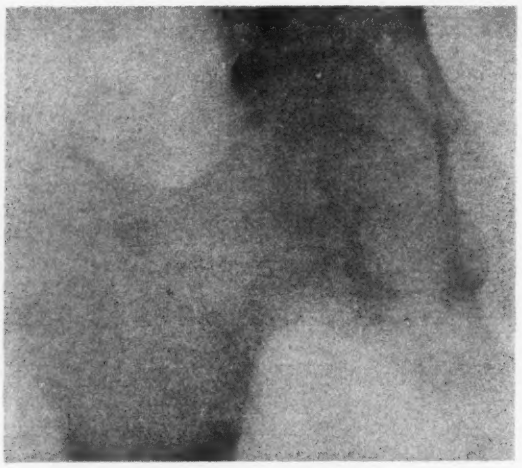


FIG. 98. Case XX. Roentgenogram two and one-half years after drilling, February 20, 1939; firm union.

CASE XX. L. G., a ten year old girl, while stepping on the rungs of a ladder had her right leg "give out" under her. *X*-ray examination, July 25, 1936, showed a complete interruption of continuity at the base of the right femoral neck. This "fracture line" was of such even smoothness that considering the nature of the accident, the diagnosis of a pathological fracture was made. (Fig. 96.) Reduction and drilling were done on July 30, 1936, and a spica applied for eight weeks. Rapid improvement followed. The patient was allowed on crutches after careful exercises in bed gave clinical evidence of union four months after the accident. On repeated *x*-ray examinations, each time in a different position, a search was made for a primary compression focus in the head. This was eventually located on *x*-ray examination made July 6, 1938. (Fig. 97.) A drilling into this focus was recommended but refused. *X*-ray examination on February 20, 1939, showed good consolidation at the fracture site, a well shaped head, satisfactory bone structure and apparently uo untoward development due to the primary compression focus. (Fig. 98.) This may be due to the circumstance that the segment harboring the focus is possibly not subjected to weight bearing. The parents report that the child is well, pursuing all activities and is unaware of any disability. The period of observation covered three and one-half years.

The reported cases of juvenile fractures of the femoral neck indicate in the opinion of the author that one cannot rely implicitly

on the vitality of these young patients to bring about repair. The delay or entire abeyance of repair is due to the presence of compressed necrotic bone at the site of interruption of continuity. The

FIG. 99. Case XXI. Left hip; roentgenogram June 23, 1937; wedge shaped compression in femoral head; beginning collapse.

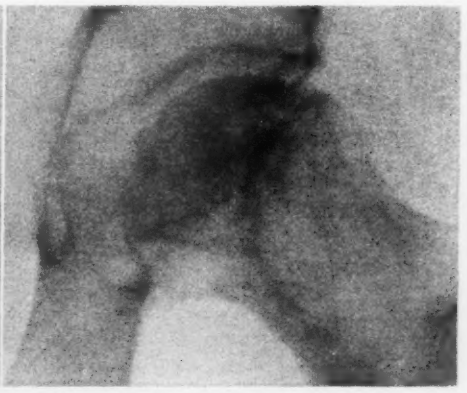


FIG. 100. Case XXI. Right hip of same patient as in Figure 99; roentgenogram June 23, 1937; wedge shape of compression focus very clearly outlined.

demonstrated presence of primary foci in the head corroborates the explanation given by the author as to the mechanism of these injuries. The analysis of these Whitman-type juvenile fractures of the femoral neck may furnish clues to the understanding of the problems of intracapsular hip fractures occurring in adults, as the former represent, as it were, the slow-motion version of the latter.

ARTHRITIS DEFORMANS OF THE HIP

CASE XXI. J. C., a forty-five year old male, was under observation with marked disability of both hips for two and one-half years. Examination revealed in both hips the condition variously called malum senile, arthritis deformans, osteoarthritis, etc. The patient had in his possession *x*-ray pictures taken at the onset of the disability, June 23, 1937. (Figs. 99 and 100.) These indicate with remarkable clearness the wedge shape of the lesion before collapse of the head occurred, indicating that the underlying cause of the disease is compression necrosis of the femoral head. The patient cannot recall any marked single accident, but reports continued hard physical labor over a period of many years prior to the inception of the disability.

INVOLVEMENT OF THE ACETABULUM

CASE XXII. M. F., an eleven year old girl, was under observation at home for pain and limp in the left hip. *X*-ray examination on June 9, 1937,

showed gross disturbance of the upper portion of the acetabulum with the formation of a partially separated sequestrum. The femoral head showed a definite primary compression focus. (Fig. 101.) The position of the two

FIG. 101. Case XXII. Roentgenogram June 9, 1937; partly separated sequestrum in acetabulum; compression focus in head.

FIG. 102. Case XXII. Roentgenogram two years later, June 2, 1939; focus in acetabulum healed; focus in head still present; beginning spur formation.

foci indicates that the injury to both occurred in marked adduction. Rest in bed and treatment by extension at home, intermittently with restricted activity were carried out. *X*-ray examination two years later, June 2, 1939, showed that the injury in the acetabulum had completely healed insofar as *x*-ray appearance was concerned. The primary compression focus on the head was still discernible with the indication of the formation of a spur. (Fig. 102.) While *x*-ray evidence showed recovery, there are, however, periods of pain and stiffening in the left hip necessitating bed rest and traction.

INVOLVEMENT OF THE SACROILIAC SYNCHONDROSES

CASE XXIII. C. H., a nineteen year old male, had pain in lower part of the back, stiffness, fatigue on slight exertion and inability to walk any but short distances. He also experienced radiating pain along the posterior aspect of both thighs. *X*-ray examination revealed marked bone destruction at both sacroiliac joints. Rest in bed and traction were used but there was little improvement. The author believing, as previously stated, that the condition was due to compression necrosis in the ilium distal to the joints, recommended drilling so as to bring about absorption of necrotic material and possibly fusion of the synchondroses. The drilling operation was performed on February 15, 1933. Drill specimens removed from the ilium revealed massive bone necrosis. (Fig. 104.) *X*-ray examination on March 20,

1933, showed the condition as it was a month after drilling. (Fig. 103.) Temporary improvement occurred but the sympoms, however, returned. Within one year both sacroiliac synchondroses fused firmly, but immedi-

FIG. 103. Case XXIII. Roentgenogram four weeks after drilling, March 20, 1933; marked bone destruction, increased density at both sacroiliac joints, especially in ilium.

ately following, arthritis of the spine (Marie-Struempell type) developed. The patient last seen February 23, 1940, is totally disabled with completely fused spine and other joint involvements.

It cannot be determined, on the one hand, whether fusion of the sacroiliac synchondroses was the result of drilling or of the disease not manifest at that time; on the other hand the possibility, however remote, exists that the drilling released a rush or wave of ossification that progressed out of bounds. Further, it must be considered as possible that there is an introductory stage of the Marie-Struempell arthritis of the spine consisting of compression damages at the sacroiliac synchondroses and along the spine, with the final picture of the disease being the result of the spontaneous ossification of these foci. This case is reported with the recommendation that drilling is not to be performed in these conditions until other cases under observation clarify the various points mentioned.

Another instance in which drilling is not recommended is the involvement of the acetabulum.

It is the impression of the author that where necrotic foci are brought into communication with muscle or connective tissue through drill channels or by their spontaneous breaking open,

FIG. 104. Case XXIII. Drill specimen; nothing but necrotic bone with empty lacunae, no living marrow elements; marked homogenization and granular breaking up of necrotic bone.

unpredictable and uncontrollable ossification or fibrosis may result. The drilling is safe if it is performed from living bone to dead bone within the boundaries of bone.

Compression and its consequences may develop in cortical bone also. Blaisdell[13] demonstrated that in young individuals at forcible bending, laminae of the cortex slide against and over one another with subsequent injury to the vessels. The author believes that this mechanism is the underlying cause of the so-called spontaneous fractures of shafts of long bones. Mechanical explanation of these occurrences on the basis of Looser's[69] original studies, is convincingly represented by Walter[116] in his later publications.

RÉSUMÉ

The author endeavored to give an outline of the concept of compression of cancellous bone, and to demonstrate that its manifestations occur from earliest childhood to advanced old age in a great variety of clinical pictures.

A method of treatment and its results were demonstrated.

An attempt was made to record the great merits of Palletta, Bell, Ollier and others in laying the foundations for understanding the group of diseases discussed.

The author is greatly indebted to Dr. Leo Mayer for the early and extensive trial accorded the treatment described, that resulted in the mass demonstration of efficacy of drilling in instances of slipped epiphyses. Cases IX and X have been taken from this material. Further, the author wishes to thank the following for the privilege of treating cases, or the use of cases treated, on their respective services: Dr. E. A. Spies (deceased), Case XII; Dr. H. Finkelstein and H. C. Stein, Case XVIII; Dr. W. Galland, Cases II and V; Dr S. Eppstein, Case VII; Dr. Th. J. O'Kane, Case XXII. Thanks are due to Dr. W. Aronson for interpreting histological findings (report of this material under preparation), and to Dr. S. Weitzner for co-operation in *x*-ray examinations.

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AUTHOR INDEX TO VOLUME LIII

Abbott, W. E., 215
Alexander, Harry H., Jr., 349
Alexander, Stewart F., 444
Ault, Garnet W., 329

Barb, Jacob S., 356
Barrow, Woolfolk, 242
Behrend, Albert, 296
Beling, C. Abbott, 219
Benjamin, Durand, 500
Benjamin, Eustace L., 172
Bennett, D. A., 340
Blodgett, James B., 271
Bornstein, Max, 333
Bottone, John J., 125
Bozsan, Eugene J., 537
Brunkow, Ben H., 440

Calman, Arthur S., 428
Cameron, David M., 455
Cantor, Alfred J., 121
Carlucci, Gaston A., 417
Castallo, Mario A., 82
Charache, Herman, 152
Clute, Howard M., 475
Cohn, Bernard N. E., 323
Coleman, E. P., 340
Collins, Conrad G., 202
Connell, F. Gregory, 255
Cornell, Nelson W., 177

Dalton, Arthur J., 490
D'Eloia, A. S., 280
Dobelle, Martin, 460
Doran, William T., 41
Doran, William T., Jr., 41
Drosin, Louis, 515

Eaton, Chelsea, 377
Eckel, John H., 345
Ehrenfeld, Irving, 470
Eichwald, E. J., 181
Ellingson, Oren, 379
Erich, John B., 2
Eversole, Urban H., 403

Fallis, Lawrence Sidney, 512
Feo, Louis G., 82
Ferguson, L. Kraeer, 88
Fey, David W., 363
Flagg, Paluel, 199
Ford, Harold, 492
Frank, L. Wallace, 412
Friedman, H. Harold, 509

Gault, Joseph T., 145
Ghormley, Ralph K., 455
Girsdansky, Joseph, 514
Glasser, S. Thomas, 131
Gnassi, Angelo M., 260
Goodnough, C. F., 506
Granet, Emil, 129
Grayzel, David M., 509
Gurdjian, E. S., 352

Hand, Leo V., 403
Hanssen, Eilif C., 41
Hauser, Louis A., 177
Helfert, Irving, 129
Heron, David F., 291
Higinbotham, Norman L., 444
Hipps, Herbert E., 314
Hobart, Marcus H., 55
Holden, W. D., 215
Hucherson, Denman C., 237
Hurd, Ralph A., 61

Johnson, Gilbert H., 349

Kaplan, Abraham, 367
Kaplan, Philip, 145
Kilfoy, Edward J., 496
King, Don, 208
Kirschbaum, Harry, 519
Kleinberg, Samuel, 168
Koster, Harry, 248
Koven, B., 13
Koven, M. T., 13
Kraft, George L., 55

Laird, Edmund G., 158
Laird, T. Kerr, 335
La Towsky, Leroy W., 88
Laufman, Harold, 381
Leonardo, Richard A., 521
Lewis, Kenneth M., 41
Lock, Frank R., 202

Macmanus, Joseph E., 393
Maguire, R. H., 340
Mersheimer, Walter, 131
Miller, A. J., 412
Monroe, Stanley E., 172
Moore, S. W., 306
Munson, Frederick T., 291
Mustard, R. L., 492

Nelson, O. A., 187
New, Gordon B., 2
Newman, Herbert F., 514
Nicholson, Morris J., 403

Ogilvie, John B., 345
Oliver, William, 284

Patton, Charles L., 265
Patton, Robert J., 265
Pennoyer, Grant P., 102
Phillips, John Roberts, 117
Phillips, Richard B., 486
Pierce, Wilmot F., 434
Posner, A. Charles, 503
Prince, Lionel D., 232

Raney, Aidan A., 370
Raney, Rupert B., 370
Richards, Victor, 208
Rigdon, R. H., 481
Riggs, Helena A., 296
Robertson, Jarratt Padgett, 421

Scannell, Raymond C., 163
Schreiber, Frederic, 188
Schwartz, Frederick L., 111
Sears, Ernest, 117
Senger, Fedor L., 125
Shatara, F. I., 32
Shiner, Irving, 131
Solovay, J., 492
Spier, Lester C. B., 41
Steinberg, M. E., 463
Stone, Meyer M., 374

Thiessen, Norman W., 94
Tractenberg, I., 284
Trumble, Hugh C., 319
Turow, Irving L., 363

Wallace, Robert P., 470
Walter, Carl W., 184
Warren, J. W., 481
Watter, Leonid, 359
Weinshel, Leo R., 333
Weiss, J. A., 190
White, J. William, 71
Wilmoth, Clifford Lee, 300

Zimmerman, Leo M., 190

SUBJECT INDEX TO VOLUME LIII

(Bo. B.) = Bookshelf Browsing; (E.) = Editorial

Abdomen, closure of incisions of, 490
Abscess, liver, and bacteroides funduliformis, 506
Abscesses, cerebral, treatment of, by traction drainage, 188
Accidents, embolic, vascular, of extremities, 440
Acid, hydrochloric, and peptic ulcer, 255
Adenocarcinoma, primary, of jejunum, 177
Age, old, appendicitis in, 242
American, I am an, and a way of life (E.), 391
Amfetin and inflammation, 481
Amniotic fluid (amfetin) and inflammation, 481
Anatomy of sphincter of Oddi, 94
Anesthesia
  as an art (E.), 199
  fractional spinal, 403
  general, and convulsions, 172
  spinal, and hemiplegia, 359
Anus and rectum, treatment for diseases of, 428
Appendicitis, acute, in youth and old age, 242
Arthrodesis, extra-articular, of knee joint, 208
Art of anesthesia (E.), 199

Behavior of muscle after infantile paralysis, 314
Bodies, foreign, ingested, and intestinal perforations, 393
Book Reviews:
  A Doctor's Holiday in Iran (Morton), 390
  Magic in a Bottle (Silverman), 388
  Test Tubes and Dragon Scales (Basil), 389
  Textbook of General Surgery (Cole and Elman), 532
  The Doctor Takes a Holiday (McKibbin-Harper), 389
  The Heart in Pregnancy and the Childbearing Age (Hamilton and Thomson), 196
Bone
  cancellous, compression of, 537
  graft, fusion by, 13
Bones
  marble, 444
  semilunar and triangular, fusion of, 349
Brain
  meningioma of, and heart disease, 367
  treatment for abscess of, 188
Brenner tumor of ovary, 509
Bullet wound of heart with suture and recovery, 131
Burns, treatment of, with sulfhydryl, 434

Canal, spinal, syringe for injecting lipiodol into, 187
Cancer, metastatic, symptoms and signs of, 486
Carcinoma
  metastatic, in uterus, 152
  of colon in a child, 335
  primary, liver cell, 260
Child, carcinoma of colon in, 335
Children, torsion of ovarian cysts in, 500
Closure of abdominal incisions, 490
Colles' fracture, malunited, 55
Colon
  carcinoma of, in a child, 335
  lipoma of, 145
Colostomy and ileostomy, 463
Colpocleisis, Le Fort, 202
Complications
  cerebral, after surgery, 296
  postoperative, in general surgery, 88
  unusual, in abdominoperineal resection, 329
Compression of cancellous bone, 537
Condyle, lateral, of tibia, fracture of, 460
Control, mechanical, of intestinal fistulae, 374
Convulsions and general anesthesia, 172
Correction, surgical, of mandibular prognathism, 2
Craniotomy, osteoplastic, 319
Cyst, omental, in infant, causing fatal ileus, 181
Cysts, ovarian, torsion of, 500

Darrach operation for radio-ulnar derangement, 237
Deformity, Madelung's, 349
Delivery, spontaneous, and puerperal septicemia, 503
Derangement, radio-ulnar, Darrach operation for, 237
Disease, heart, and cerebral meningioma, 367
Diseases, anorectal, submucous method for, 428
Disorders, intestinal, and hypoprothrombinemia, 215
Dissector, blunt, and sponge forceps, 519
Distention, postoperative, use of prostigmin for, 284
Drainage, traction, for cerebral abscesses, 188
Dyschondroplasia of epiphysis with fusion of bones, 349

Edkins' theory and peptic ulcer, 255
Elbow, osteochondritis dessicans of, 496
Electrocardiograms and wound of heart, 492
Embolism, vascular, of extremities, 440
Endometriosis
  observations on, 61
  of sigmoid and intestinal obstruction, 265
Enteritis
  regional, 345
    intestinal hemorrhage in, 512
Epiphysis, distal radial, dyschondroplasia of, 349
Ether convulsions, 172
Excision, partial, of fragments, 232
Extremities
  arterial disease of, 102
  embolic accidents to, 440
Extrusion of Smith-Petersen nail in femoral fractures, 32

Face
  reconstruction of, with acrylic resin, 291
    with tubed pedicle graft, 300
Femur
  fractures of neck of, 32
  osteoma of, 168
Fistula, gastrojejunocolic, 333
Fistulae, intestinal, apparatus for control of, 374
Forceps
  Kielland, modified, 515
  sponge, and blunt dissector, 519
  transfer, sterile, 184
Fracture
  Colles', malunited, 55
  of tibia, closed reduction for, 460
  spontaneous, pathologic, and diaphyseal tuberculosis, 323
Fractures
  intracapsular, of neck of femur, 32
  of patella, treatment of, 232
Fragments, partial excision of, in treatment of fractures of patella, 232
Fusion
  by bone graft, for osteomyelitis of spine, 13
  of semilunar and triangular bones in dyschondroplasia, 349

Gallbladder, surgery of, 41
Graft
  bone, fusion by, 13
  tubed pedicle, in facial reconstruction, 300

Heart
  bullet wound of, 131
  disease of, and cerebral meningioma, 367
  wound of, and electrocardiograms, 492
Hemangioma, deep, cavernous, of neck, 158
Hemiplegia after spinal anesthesia, 359
Hemorrhage
  delayed, and rupture of spleen, 363
  intestinal, in regional enteritis, 512
  ovarian, 82
Hemorrhoids, history of (Bo. B.), 381
Hydroceles, large, injection of, with sodium morrhuate, 421
Hypoprothrombinemia in intestinal disorders, 215
Hysterectomy, total, 117

Ileostomy and colostomy, 463
Ileus, fatal, and omental cyst, 181
Incisions, abdominal, closure of, 490
Infant, omental cyst in, 181
Infections, staphylococcic, treatment of, with thiazole derivatives, 219
Injection of hydroceles with sodium morrhuate, 421
Intestine
  disorders of, 215
  fistulae of, 374
  hemorrhage of, in regional enteritis, 512
  obstruction of, and endometriosis, 265
  perforations of, by foreign bodies, 393
  peritonitis after resection or perforation of, 248
Intussusception, jejunal, recurring, 340
Iron in peptic ulcer therapy, 470

Jejunum
  adenocarcinoma of, 177
  intussusception into, 340
Joint
  knee, arthrodesis of, 208
    synovectomy of, 455

Knee, joint of, arthrodesis of, 208
Kielland forceps, modified, 515

Leakage after intestinal resection or perforation, peritonitis from, 248
Le Fort colpocleisis, 202
Lesions, pyloric, obstructing, surgery for, 417
Lipiodol, syringe for, 187
Lipoma, submucous, of colon, 145
Liver
  abscess of, 506
  cell, primary carcinoma of, 260

Madelung's deformity, 349
Malignancy of vulva, 412
Medicolegal problems and advances made (Bo. B.), 521
Melanoma, subungual, 163
Meningioma, cerebral, removal of, in coronary heart disease, 367
Meningitis, traumatic, management of, 352
Metastasis in cancer, symptoms and signs of, 486
Method, submucous, for anorectal diseases, 428
Miller-Abbott tube, satisfactory use of, 271
Mortality in general surgery, 88
Muscle, behavior of, after infantile paralysis, 314
Myth, biblical, of brazen serpent (Bo. B), 190

Nail
  melanoma beneath, 163
  Smith-Petersen, extrusion of, 32
National defense, rubber goods for (E.), 1
Neck, hemangioma of, 158
Neurosurgery, power units in, 370

Obstruction, intestinal, and endometriosis of sigmoid, 265
Occlusion, peripheral, arterial, 102
Operation
  cerebral, complications after, 296
  Darrach, for radio-ulnar derangement, 237
Operations
  abdominal and vaginal, use of prostigmin after, 284
  general surgical, complications and mortality in, 88
  secondary, on biliary tract, 475
Osteochondritis dessicans of left elbow, 496
Osteoma, osteoid, of femur, 168
Osteomyelitis of spine and fusion by bone graft, 13
Osteopetrosis, 444
Ovary
  Brenner tumor of, 509
  cysts of, torsion of, 500
  hemorrhage of, 82

Papilloma, benign, of renal pelvis, 125
Paralysis, infantile, muscle behavior after, 314
Patella, fractures of, 232
Pelvis, renal, benign papilloma of, 125
Perforation of intestine, peritonitis after, 248
Perforations of intestine by ingested foreign bodies, 393
Peritonitis, prevention and diminishing of, 248
Pneumogastroscopy, 280
Problems, medicolegal (Bo. B.), 521
Proctoscope, new, 377
Prognathism, mandibular, surgical correction of, 2
Prolapse, uterine, 111
Prostigmin, use of, for postoperative distention and urinary retention, 284
Pruritus ani, 121
Puerperal septicemia and spontaneous delivery, 503
Pylephlebitis and sulfanilamide, 356
Pylorus, surgery for obstructing lesions of, 417

Rabies, 306
Reconstruction
  facial, tubed pedicle graft in, 300
  with acrylic resin, 291
Rectum, urinary retention after surgery upon, 129
Reduction, closed, of fracture of lateral condyle of tibia, 460
Resection
  abdominoperineal, with complications, 329
  of intestine, peritonitis after, 248
Resin, acrylic, use of, in facial reconstruction, 291
Results, end, of synovectomy of knee joint, 455
Retention
  acute, urinary, after surgery, 129
  urinary, use of prostigmin for, 284
Retractor, rubber, intra-abdominal, 379
Rubber, for national defense (E.), 1
Rupture, traumatic, of spleen, and hemorrhage, 363

Septicemia, puerperal, and spontaneous delivery, 503
Serpent, brazen, biblical myth of (Bo. B.), 190

Sigmoid, endometriosis of, and intestinal obstruction, 265
Sodium morrhuate for hydroceles, 421
Solution, sulfhydryl, for burns, 434
Sphincter of Oddi, anatomy of, 94
Spine, osteomyelitis of, 13
Spleen, normal, rupture of, 363
Sponge forceps and blunt dissector, 519
Sulfanilamide
  for pylephlebitis, 356
  thiazole derivatives of, 219
Sulfhydryl, use of, for burns, 434
Surgery
  anorectal and perineal urinary retention after, 129
  gallbladder, 41
  in aged with obstructing pyloric lesions, 417
  plastic, use of acrylic resin in, 291
Suture of cardiac auricle, 131
Synovectomy, of knee joint, end results in, 455
Syringe for injecting lipiodal into spinal canal, 187

Tattoo therapy in pruritus ani, 121
Testicle, vitallium implant in, 514
Therapy, peptic ulcer, use of iron in, 470
Thiazole derivatives of sulfanilamide for staphylococcic infections, 219
Tibia, lateral condyle of, fracture of, 460
Torsion of ovarian cysts in children, 500
Tract, biliary, operations on, 475
Trauma, meningitis caused by, 352
Tube, Miller-Abbott, 271
Tuberculosis, diaphyseal, and spontaneous pathologic fracture, 323
Tumor, Brenner, of ovary, 509
Tumors, multiple, primary malignant, 71

Ulcer
  peptic, hydrochloric acid and Edkins' theory, 255
    use of iron for, 470
Units, pneumatic and electric, in neurosurgery, 370
Uterus
  carcinoma of, 152
  prolapse of, 111

Vitallium testicular implant, 514
Vulva, malignancy of, 412

Way of life, and I am an American (E.), 391
Wound
  bullet, of cardiac auricle, 131
  of heart and electrocardiographic tracings, 492

Youth, appendicitis in, 242

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CONTENTS OF NEW SERIES, VOLUME LIII

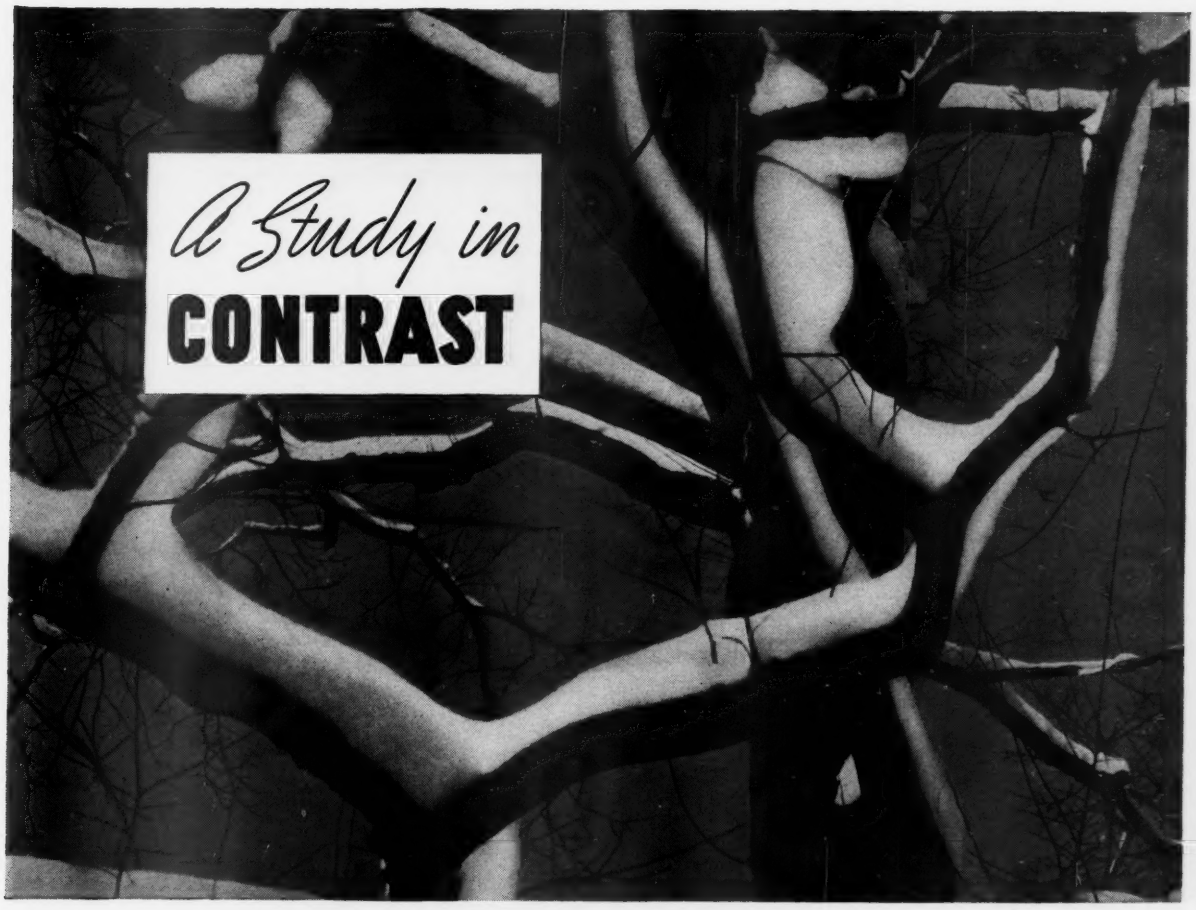
ORIGINAL ARTICLES

Surgical Correction of Mandibular Prognathism.	*Gordon B. New*, *John B. Erich*	2
Osteomyelitis of the Spine Treated with Fusion by Bone Graft	*B. Koven*, *M. T. Koven*	13
Extrusion of the Smith-Petersen Nail in Intracapsular Fractures of the Neck of the Femur	*F. I. Shatara*	32
Gallbladder Surgery. A Ten Years' Statistical Review Including 410 Operated Cases	*William T. Doran*, *Kenneth M. Lewis*, *Eilif C. Hanssen*, *Lester C. B. Spier*, *William T. Doran, Jr.*	41
Malunited Colles' Fracture.	*Marcus H. Hobart*, *George L. Kraft*	55
Some Observations on Endometriosis.	*Ralph A. Hurd*	61
Multiple Primary Malignant Tumors. Report of Two Cases	*J. William White*	71
Ovarian Hemorrhage. An Analysis of Twenty-eight Cases from the Records of the Jefferson Medical College Hospital, 1930 to 1939 Inclusive	*Mario A. Castallo*, *Louis G. Feo*	82
Study of the Immediate Postoperative Complications and Mortality in Certain General Surgical Operations. Analysis of 662 Cases at the Philadelphia General Hospital, 1936 to 1939	*L. Kraeer Ferguson*, *Leroy W. La Towsky*	88
Anatomy of the Sphincter of Oddi	*Norman W. Thiessen*	94
Peripheral Arterial Occlusion	*Grant P. Pennoyer*	102
Uterine Prolapse. An *X*-ray Study	*Frederick L. Schwartz*	111
Total Hysterectomy.	*John Roberts Phillips*, *Ernest Sears*	117
Pruritus Ani	*Alfred J. Cantor*	121
Benign Papilloma of the Renal Pelvis.	*Fedor L. Senger*, *John J. Bottone*	125
Prevention of Acute Urinary Retention Following Anorectal and Perineal Surgical Procedures	*Irving Helfert*, *Emil Granet*	129
Bullet Wound of Left Cardiac Auricle with Suture and Recovery. A Review of the Literature	*S. Thomas Glasser*, *Walter Mersheimer*, *Irving Shiner*	131
Submucous Lipoma of the Colon. Report of a Case.	*Joseph T. Gault*, *Philip Kaplan*	145
Metastatic Carcinoma in the Uterus	*Herman Charache*	152
Deep Cavernous Hemangioma of the Neck. Case Report	*Edmund G. Laird*	158
Subungual Melanoma. Report of a Case	*Raymond C. Scannell*	163
Osteoid Osteoma of the Femur. Report of a Case	*Samuel Kleinberg*	168
Convulsions Associated with General Anesthesia: "Ether Convulsions." Report of a Case with Findings at Autopsy	*Stanley E. Monroe*, *Eustace L. Benjamin*	172

Primary Adenocarcinoma of the Jejunum. Report of a Case.	*Nelson W. Cornell*, *Louis A. Hauser*	177
Case of an Omental Cyst in a Three Weeks' Old Female, Causing Fatal Ileus	*E. J. Eichwald*	181
Sterile Transfer Forceps.	*Carl W. Walter*	184
Syringe for Injecting Lipiodol into the Spinal Canal	*O. A. Nelson.*	187
Treatment of Cerebral Abscesses by Traction Drainage	*Frederic Schreiber*	188
Biblical Myth of the Brazen Serpent	*Leo M. Zimmerman*, *J. A. Weiss*	190
Le Fort Colpocleisis. An Analysis of Thirty-one Cases with a Description of the Technic Used by the Authors	*Conrad G. Collins*, *Frank R. Lock*	202
Extra-articular Arthrodesis of the Knee Joint	*Don King*, *Victor Richards*	208
Hypoprothrombinemia in Intestinal Disorders	*W. E. Abbott*, *W. D. Holden*	215
Treatment of Staphylococcic Infections with Thiazole Derivatives of Sulfanilamide.	*C. Abbott Beling.*	219
Treatment of Fractures of the Patella by Partial Excision of Fragments.	*Lionel D. Prince.*	232
Darrach Operation for Lower Radio-ulnar Derangement	*Denman C. Hucherson*	237
Acute Appendicitis in Youth and Old Age	*Woolfolk Barrow.*	242
Method for Preventing or Diminishing Peritonitis from Leakage after Intestinal Resection or Perforation.	*Harry Koster.*	248
Peptic Ulcer, Hydrochloric Acid and Edkins' Theory	*F. Gregory Connell*	255
Primary Liver Cell Carcinoma.	*Angelo M. Gnassi*	260
Endometriosis of Sigmoid as a Cause of Acute Intestinal Obstruction	*Charles L. Patton*, *Robert J. Patton.*	265
Technic for the Satisfactory Use of the Miller-Abbott Tube	*James B. Blodgett*	271
Pneumogastroscopy. A Preliminary Report	*A. S. D'Eloia*	280
Use of Prostigmin in Abdominal and Vaginal Operations for the Relief of Postoperative Distention and Urinary Retention in a Series of 96 Consecutive Cases	*I. Tractenberg*, *William Oliver*	284
Facial Reconstruction with Acrylic Resin	*Frederick T. Munson*, *David F. Heron*	291
Cerebral Complications Following Surgical Operation. Prevention and Treatment	*Albert Behrend*, *Helena A. Riggs.*	296
Tubed Pedicle Graft in Facial Reconstruction. Its Superiority When Subcutaneous Loss Is Present	*Clifford Lee Wilmoth*	300
Rabies.	*S. W. Moore.*	306
Muscle Behavior Following Infantile Paralysis	*Herbert E. Hipps*	314
Osteoplastic Craniotomy	*Hugh C. Trumble*	319
Diaphyseal Tuberculosis. Report of a Case with Rapid Destruction and Spontaneous Pathologic Fracture	*Bernard N. E. Cohn*	323
Abdominoperineal Resection with Unusual Complications	*Garnet W. Ault*	329
Gastrojejunocolic Fistula. Report of a Case	*Max Bornstein*, *Leo R. Weinsbel.*	333
Carcinoma of the Colon in a Child of Fourteen Years. With a Review of the Literature	*T. Kerr Laird*	335

Recurring Jejunal Intussusception.	*E. P. Coleman, R. H. Maguire, D. A. Bennett*	340
Regional Enteritis. Report of Twenty-one Cases	*John H. Eckel, John B. Ogilvie*	345
Dyschondroplasia of the Distal Radial Epiphysis (Madelung's Deformity) with Fusion of the Semilunar and Triangular Bones	*Harry H. Alexander, Jr., Gilbert H. Johnson*	349
Management of Traumatic Meningitis	*E. S. Gurdjian*	352
Pylephlebitis: Response to Sulphanilamide	*Jacob S. Barb*	356
Hemiplegia Following Spinal Anesthesia. Report of a Case	*Leonid Watter*	359
Traumatic Rupture of Normal Spleen with Delayed Hemorrhage. Report of a Case	*David W. Fey, Irving L. Turow*	363
Removal of a Cerebral Meningioma in a Patient with Severe Coronary Heart Disease	*Abraham Kaplan*	367
Pneumatic and Electric Power Units Modified for Practical Use in Neurosurgery	*Rupert B. Raney, Aidan A. Raney*	370
New Apparatus for Mechanical Control of Intestinal Fistulae. A Preliminary Report	*Meyer M. Stone*	374
New Proctoscope	*Chelsea Eaton*	377
Intra-abdominal Rubber Retractor	*Oren Ellingson*	379
History of Hemorrhoids	*Harold Laufman*	381
Perforations of the Intestine by Ingested Foreign Bodies. Report of Two Cases and Review of the Literature	*Joseph E. Macmanus*	393
Fractional Spinal Anesthesia	*Morris J. Nicholson, Urban H. Eversole, Leo V. Hand*	403
Malignancy of the Vulva	*L. Wallace Frank, A. J. Miller*	412
Surgery in Patients over Fifty with Obstructing Pyloric Lesions	*Gaston A. Carlucci*	417
Treatment of Large Hydroceles by Injection of Sodium Morrhuate	*Jarratt Padgett Robertson*	421
Submucous Method in the Treatment of Anorectal Diseases	*Arthur S. Calman*	428
Use of a Sulfhydryl Solution in the Treatment of Burns. Preliminary Report	*Wilmot F. Pierce*	434
Embolic Vascular Accidents of the Extremities	*Ben H. Brunkow*	440
Osteopetrosis. Four Cases in One Family	*Norman L. Higinbotham, Stewart F. Alexander*	444
End Results of Synovectomy of the Knee Joint	*Ralph K. Ghormley, David M. Cameron*	455
New Method of Closed Reduction of Fracture of the Lateral Condyle of the Tibia	*Martin Dobelle*	460
Colostomy and Ileostomy: A New Method	*M. E. Steinberg*	463
Iron as a Therapeutic Supplement in Peptic Ulcer Therapy	*Irving Ehrenfeld, Robert P. Wallace*	470
Secondary Operations on the Biliary Tract	*Howard M. Clute*	475
Amniotic Fluid (Amfetin) in Its Relation to Inflammation. Observations in the Rabbit and in Man	*R. H. Rigdon, J. W. Warren*	481

Symptoms and Signs of Metastatic Cancer	*Richard B. Phillips*	486
Closure of Difficult Abdominal Incisions	*Arthur J. Dalton*	490
Penetrating Wound of the Heart with Electrocardiographic Tracings	*R. L. Mustard, J. Solovay, Harold Ford*	492
Osteochondritis Dessicans of the Left Elbow	*Edward J. Kilfoy*	496
Torsion of Ovarian Cysts in Children. Report of a Case with Recovery	*Durand Benjamin*	500
Puerperal Septicemia Following Spontaneous Delivery. Report of a Fatal Case	*A. Charles Posner*	503
Liver Abscess Caused by Bacteroides Funduliformis	*C. F. Goodnough*	506
Brenner Tumor of the Ovary	*David M. Grayzel, H. Harold Friedman*	509
Massive Intestinal Hemorrhage in Regional Enteritis. Report of a Case	*Lawrence Sidney Fallis*	512
Use of a Vitallium Testicular Implant	*Joseph Girsdansky, Herbert F. Newman*	514
Modified Kielland Forceps and Principles of Application	*Louis Drosin*	515
New Sponge Forceps and Blunt Dissector	*Harry Kirschbaum*	519
Medicolegal Problems and Advances Made in Connection Therewith	*Richard A. Leonardo*	521
Compression of Cancellous Bone	*Eugene J. Bozsan*	537



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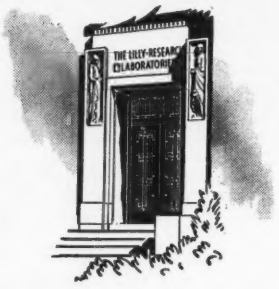

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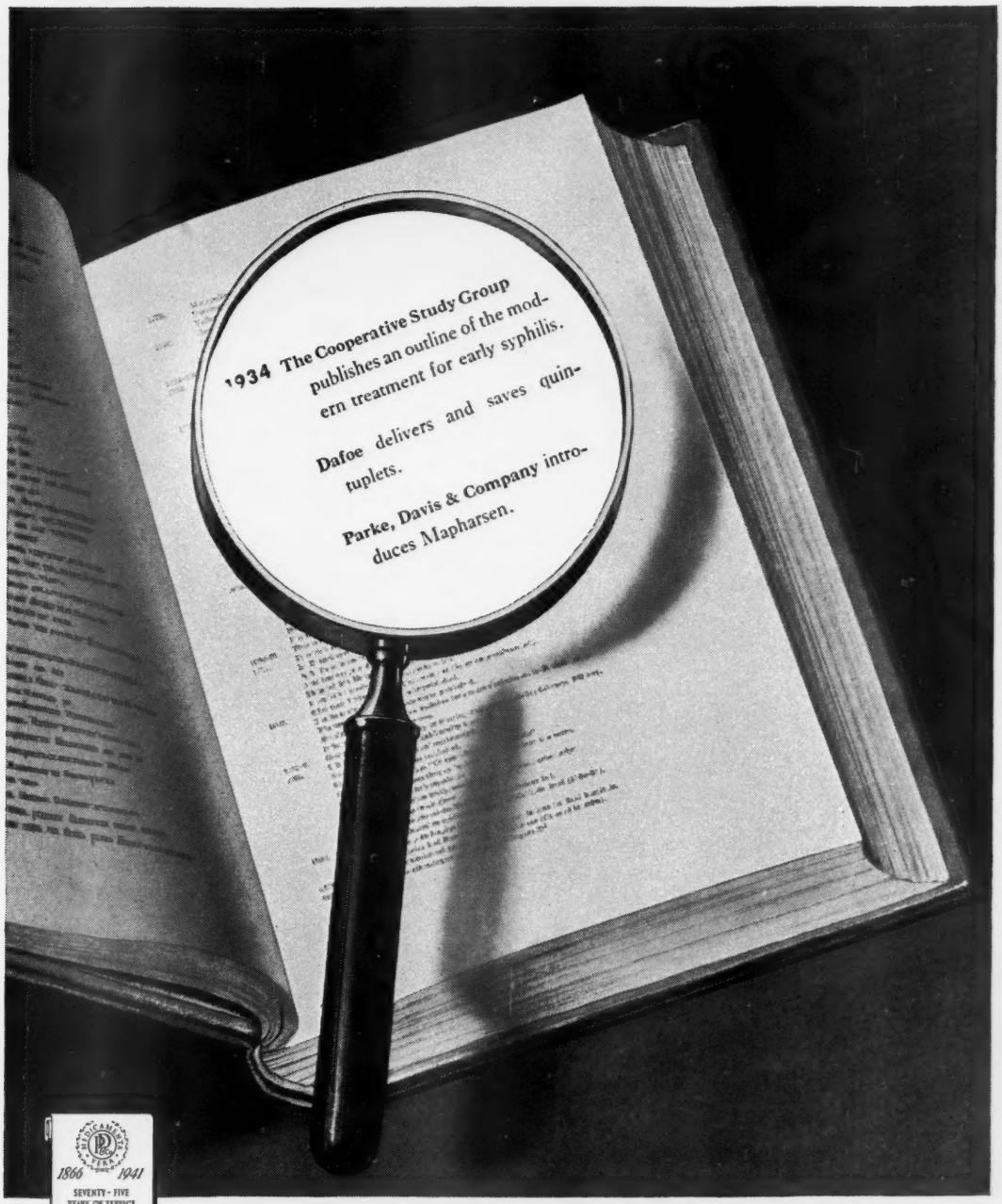
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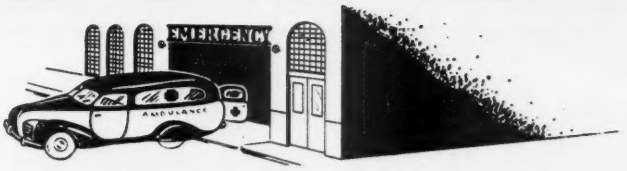

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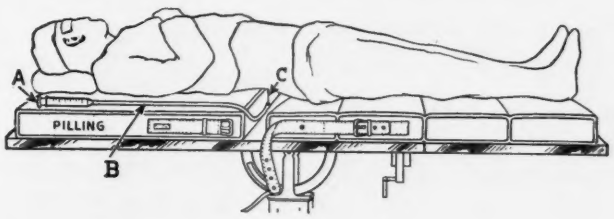

See Pages 403-411 *This Issue*

Also an interesting reprint sent on request, wherein Dr. Lemmon describes over 1100 various operations with Continuous Spinal Anesthesia using this Equipment. May be used on any operating table.

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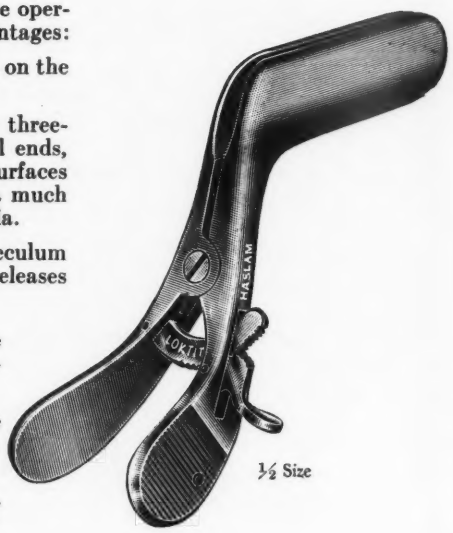

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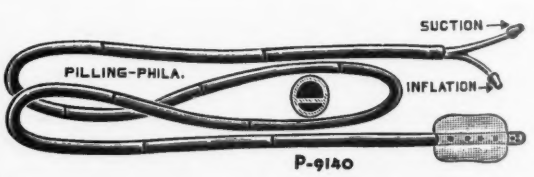

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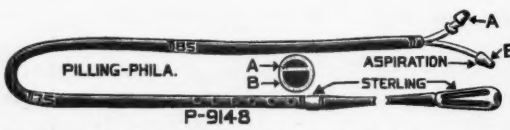
Circular on request with technique and bibliography. . . Also see page 271 of the August issue, "A Technic for the Satisfactory Use of the Miller-Abbott Tube," by Dr. James B. Blodgett, Peter Bent Brigham Hospital, Boston.

ABBOTT-RAWSON DOUBLE BARRELLED GASTRO-ENTEROSTOMY TUBE



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See Journal of the American Medical Association, June 10, 1939. Annals of Surgery, October 1940. Price.....$6.50

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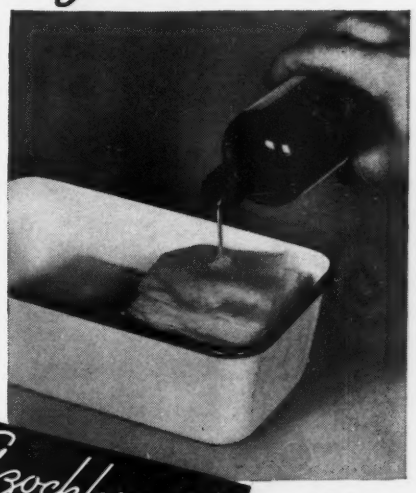

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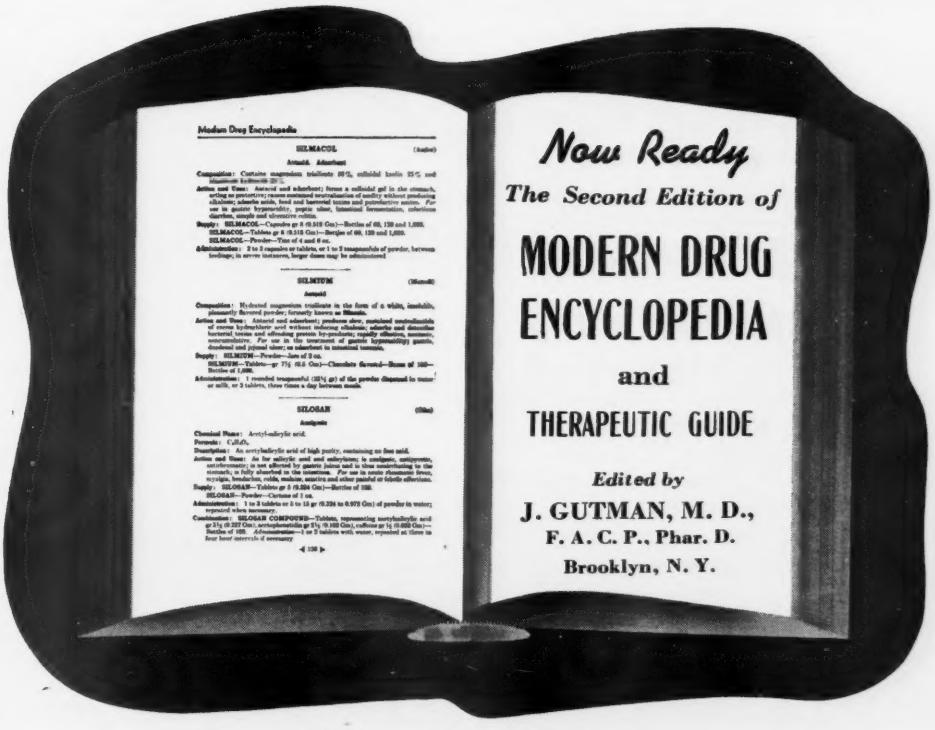

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†Curtis, Arthur C., and Kline, E. M.: Influence of liquid petrolatum on blood content of carotene in human beings, Arch. Int. Med. 63:54-63

Curtis, Arthur C., and Ballmer, R. S.: Prevention of carotene absorption by liquid petrolatum, J.A.M.A. 113:1785-1788

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Instruments and Apparatus

Austenal Laboratories, Inc. 26
Bard-Parker Co., Inc. ..... *August*
W. A. Baum Co., Inc. 1
Crescent Surgical Sales Co., Inc. 26
General Electric X-ray Corp. 13
Fred Haslam & Co., Inc. 28
Parker, White & Heyl, Inc. ..... *August*
Picker X-ray Corp. ..... *August*
Geo. P. Pilling & Son Co. 27, 28
J. Sklar Manufacturing Co. 5
Edward Weck & Co., Inc. 7

Sutures

Davis & Geck, Inc. ..... *Insert facing 2nd Cover*
J. A. Deknatel & Son, Inc. 11
Johnson & Johnson 16

Pharmaceuticals

Abbott Laboratories 10
Alba Pharmaceutical Co., Inc. 15
American Hospital Supply Corp. 9, 29
The Arlington Chemical Co. ..... *August*
The Armour Laboratories ..... *August*
Baxter Laboratories, Inc. 9, 29
Ciba Pharmaceutical Products, Inc. ..... *4th Cover*
Hoffmann-La Roche, Inc. 2
Hynson, Westcott & Dunning, Inc. 33
The Lavoris Company 31
Lederle Laboratories, Inc. 6
Thos. Leeming & Co., Inc. ..... *August*
E. C. Lientz & Co., Inc. 27
Eli Lilly and Company 18
Mallinckrodt Chemical Works 17
Merck & Co., Inc. 19
Ortho Products, Inc. 34
Park, Davis & Co. 21
Petrolagar Laboratories, Inc. 14
Schering Corporation 23
Schering & Glatz, Inc. ..... *June*
E. R. Squibb & Sons 8
Frederick Stearns & Co. ..... *August*
The Upjohn Co. 32
Wallace & Tiernan Products, Inc. 29
Wm. R. Warner & Co., Inc. ..... *August*
Winthrop Chemical Co., Inc. 20
John Wyeth & Bro., Inc. 22

Hospital Supplies

American Hospital Supply Corp. 9, 29
Baxter Laboratories, Inc. 9, 29
Becton, Dickinson & Co. ..... *August*
Crescent Surgical Sales Co., Inc. 26
Duke Laboratories, Inc. ..... *May*
General Electric X-ray Corp. 13
Fred Haslam & Co., Inc. 28
Johnson & Johnson ..... *August*
Massillon Rubber Co. 33
Picker X-ray Corp. ..... *August*
J. Sklar Manufacturing Co. 5

Post-Graduate Instruction

Cook County Grad. Sch. of Med. 25
N. Y. Polyclinic Med. School 25

Foods

Chas. B. Knox Gelatine Co., Inc. 30
The Wander Company ..... *August*

Miscellaneous

The American Journal of Surgery 12
General Information 4
Little, Brown & Company ..... *August*
New Modern Drugs 31
Society Meetings 24

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